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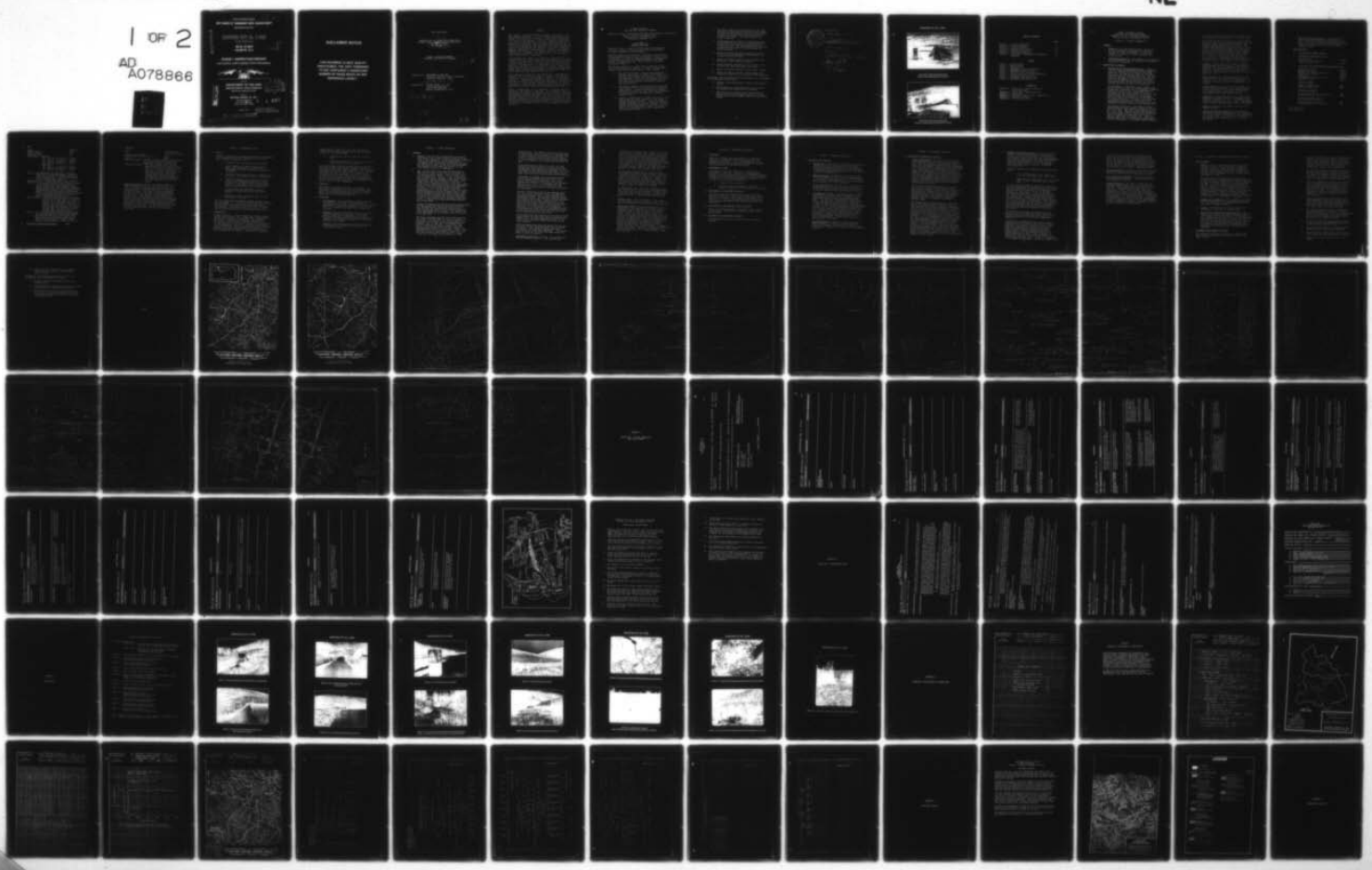

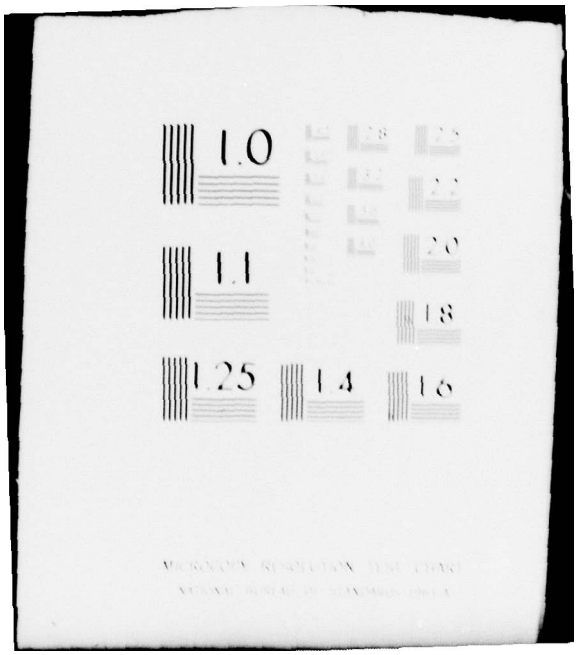
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OHIO RIVER BASIN

WEST BRANCH OF TUNUNGWANT CREEK, McKEAN COUNTY

PENNSYLVANIA

BRADFORD CITY No. 5 DAM

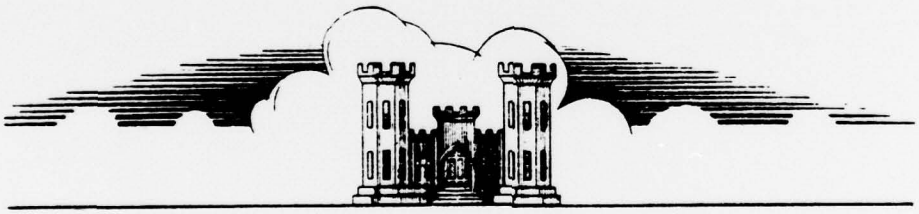
(TUNA CREEK DAM)

NDI No. PA 00026

PennDER No. 42-31

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY

Baltimore District, Corps of Engineers

Baltimore, Maryland 21203

prepared by

MICHAEL BAKER, JR., INC.

Consulting Engineers

4301 Dutch Ridge Road

Beaver, Pennsylvania 15009

AUGUST 1979

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OHIO RIVER BASIN

BRADFORD CITY No. 5 DAM (TUNA CREEK DAM)
McKEAN COUNTY, COMMONWEALTH OF PENNSYLVANIA
NDI No. PA 00026
PennDER No. 42-31

(6) PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM.
Bradford City Number 5 Dam (Tuna Creek Dam)
Ohio River Basin, West Branch of Tunungwant
Creek, McKean County, Pennsylvania.
Phase I Inspection Report,

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(15) DACW31-79-C-0011

Prepared by: MICHAEL BAKER, JR., INC.
Consulting Engineers
4301 Dutch Ridge Road
Beaver, Pennsylvania 15009

(10) Chuan Yuan Chen

(11) Aug 79

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PREFACE

This report was prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Bradford City No. 5 Dam (Tuna Creek Dam), McKean County, Pennsylvania
NDI No. PA 00026, PennDER No. 42-31
West Branch of Tunungwant Creek
Inspected 8 November 1978

ASSESSMENT OF GENERAL CONDITIONS

Bradford City No. 5 Dam is a "High" hazard-"Intermediate" size dam. The dam is owned and operated by the Bradford City Water Authority for water supply.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for *Phase I Inspection Reports*, revealed that the spillway will pass the Probable Maximum Flood (PMF) without overtopping the dam. The spillway is therefore considered "adequate."

The dam was found to be in good overall condition at the time of the inspection. However, the owner should perform several items of work without delay. These include:

1) The owner should have a qualified professional engineer investigate, in detail, the cause of the vertical holes downstream from the toe drain of the embankment. Also, the condition of the 4 inch tile drain and the cause of the seepage exiting near this area should be evaluated as a part of the investigation.

2) Periodically examine the seepage exiting from the left side of the in situ knoll near the spillway chute channel. Should the quantity of seepage or turbidity increase with time, the condition should be studied in detail and appropriate remedial measures taken.

3) Install a seepage weir to monitor the rate of flow from behind the right wing wall of the outlet conduit head wall structure. This weir should be checked frequently for rate of flow and turbidity, and the measurements should be recorded. If the results of the measurements indicate a change in quantity or turbidity of the flow, appropriate action should be taken.

4) The outlet pipe for the catch basin on the right abutment (to the right of the access road) should be repaired and extended below the outlet conduit head wall structure. This repair may help to decrease the volume of flow exiting near the outlet structure.

5) The drainage gutter should be extended below the outlet head wall structure, or a pipe should be installed to carry the flow downstream of the outlet structure. This modification may also help to reduce the volume of flow exiting near the outlet structure.

6) Remove the trees and brush presently growing in the toe drain and immediately downstream of the toe drain (within 50 feet).

7) Repair the animal burrows in the embankment and establish a rodent control program.

8) Where necessary, replace the joint filler in the spillway and other appurtenant structures.

9) Repair the spalled concrete in the outlet conduit.

10) Remove the debris from the outlet channels and continue to remove it in the future, when necessary.

In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

Submitted by:

MICHAEL BAKER, JR., INC.

C. Y. Chen

C. Y. Chen, Ph.D., P.E.
Engineering Manager-Geotechnical

Date: 24 August 1979

Approved by:

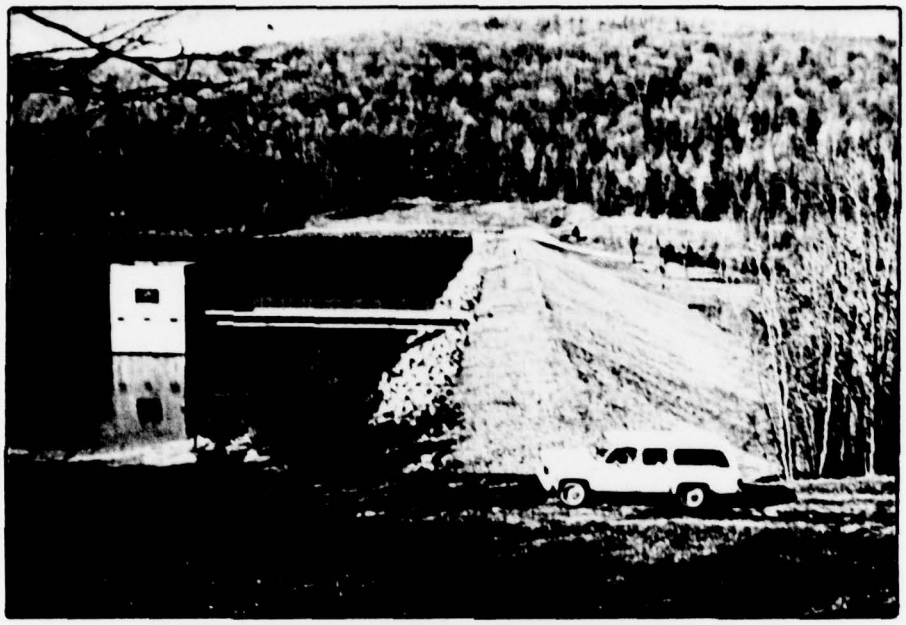
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

James W. Peck

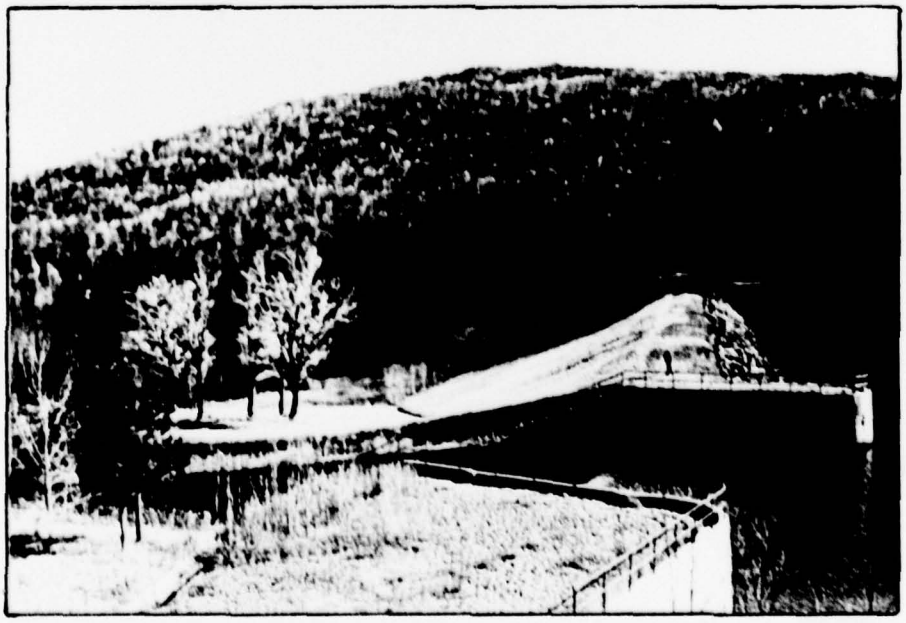
JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 12 Sep 79

BRADFORD CITY No. 5 DAM



Overall View of Dam from Right Abutment
(Intake Tower and Walkway in Left of Photo)



Overall View of Dam from Left Abutment
(Entrance to Ogee Spillway at Right-Bottom of Photo)

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NATIONAL DAM INSPECTION PROGRAM
BRADFORD CITY No. 5 DAM (TUNA CREEK DAM)
NDI No. PA 00026, PennDER No. 42-31

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Bradford City No. 5 Dam and Reservoir is a water supply dam owned and operated by the Bradford City Water Authority. The dam is also known by the names Tuna Creek Dam and Hazelton Mills Dam. The total length of the dam is approximately 1200 feet of which the embankment is 1100 feet and the crest width of the ogee section spillway is 93 feet. The maximum height of the dam is 68 feet and the maximum reservoir storage is 3390 acre-feet.

The embankment is reportedly zoned; however, the actual zoning was left up to the resident engineer's discretion. The borrow for the embankment was from the reservoir area. The slopes of the embankment are 2H:1V (Horizontal to Vertical) near the crest and the inclinations of the slopes become flatter near the base of the embankment. The crest width is 20 feet at El. 1723.0 feet and is protected by gravel. A single line grout curtain was installed below the right side of the embankment and below the key of the ogee spillway.

The spillway consists of a reinforced concrete ogee section and chute channel located at the left end of the dam. The crest of the spillway is at El. 1712.0 feet. The ogee section was designed to be 14 feet high; however, during construction the base was lowered an additional 5 to 10 feet to seat the ogee section on sound rock. The chute channel exits into a stilling basin approximately 260 feet downstream. A tailwater control structure

is located downstream from the stilling basin and the elevation of the structure is El. 1653.0 feet.

The intake and outlet structure is located approximately 325 feet from the right abutment. An 8 foot diameter conduit extends 240 feet upstream and 416 feet downstream from the riser tower. The conduit was constructed in place and has 26 cut-off collars along the downstream portion. The riser unit has three levels of intake for water supply purposes: 1) the 8 foot diameter intake conduit, 2) a 2 foot by 2 foot sluice gate at El. 1688.0 feet, and 3) 2 foot by 2 foot sluice gate at El. 1700.0 feet. Drawdown of the reservoir is controlled by a 4 foot diameter sluice gate at the entrance to the 8 foot diameter outlet conduit.

b. Location - Bradford City No. 5 Dam is located in Bradford Township, McKean County, Pennsylvania, approximately 6 miles southwest of the center of Bradford. The dam and reservoir are located in a primarily forested area 3.5 miles west of U.S. Route 219. The coordinates of the dam are N 41° 53.8' and W 78° 43.3'.

c. Size Classification - The maximum height of the dam is 68 feet. The reservoir volume to the top of dam at El. 1723.0 feet is 3390 acre-feet. Therefore, the dam is in the "Intermediate" size category.

d. Hazard Classification - Many lives could be lost in the event of a failure of the dam because of several residences located along the West Branch of Tunungwant Creek. Therefore, this dam is considered in the "High" hazard category.

e. Ownership - The dam and reservoir are owned by the Bradford City Water Authority, 24 Kennedy Street, Bradford, Pennsylvania 16701. The present water authority chairman is Mr. O. C. Knott. The present water authority superintendent is Mr. Pat A. Nuzzo.

f. Purpose of the Dam - The dam is used for water supply storage.

g. Design and Construction History - The dam was designed by Gannett Fleming Corddry and Carpenter, Inc. of Harrisburg, Pennsylvania. The construction of the dam, from 20 June 1955 to 11 July 1957, was performed by Buck and Donohue, Inc. of Newark, New Jersey.

h. Normal Operating Procedures - The reservoir is maintained at approximately the same level all year. Personnel of the water authority visit the chlorinator house downstream from the dam daily to regulate and maintain the chlorine for water supply purposes.

1.3 PERTINENT DATA

a. Drainage Area (square miles) -	6.6
b. Discharge at Dam Site (c.f.s.) -	
Maximum Flood -	Unknown
Ungated Spillway Capacity (El. 1723.0 ft.) -	13,800
c. Elevation (feet above Mean Sea Level [M.S.L.]) -	
Design Top of Dam -	1723.0
Minimum Top of Dam -	1723.0
Maximum Pool (Phase I Analysis*) -	1720.2
Maximum Pool (Design) -	Unknown
Normal Pool -	1712.0
Streambed at Centerline of Dam -	1655
Maximum Tailwater -	1664.6
d. Reservoir (feet) -	
Length of Maximum Pool -	4400
Length of Normal Pool -	3900
e. Storage (acre-feet) -	
At Top of Dam (El. 1723.0 ft.) -	3390
At Spillway Crest (El. 1712.0 ft.) -	2090
f. Reservoir Surface (acres)	
Top of Dam (El. 1723.0 ft.) -	133
Spillway Crest (El. 1712.0 ft.) -	102

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* See Appendix D

g. Dam -

Type -	Earthfill
Length (feet) -	1200
Height (feet) -	68
Top Width (feet) -	20
Side Slopes - Upstream -	
El. 1723 ft. to 1710 ft. -	2H:1V
El. 1710 ft. to 1690 ft. -	2.5H:1V
El. 1690 ft. to 1670 ft. -	4H:1V
El. 1670 ft. and below -	20H:1V
Downstream -	
El. 1723 ft. to 1700 ft. -	2H:1V
El. 1700 ft. to 1680 ft. -	2.5H:1V
El. 1680 ft. and below -	4H:1V

Zoning - The embankment was specified to be constructed of "rolled embankment, compacted, impervious material of selected mixture of clay, sand and gravel, increasing in permeability toward outer slopes."

Impervious Core - As specified above under "Zoning."

Cut-off - A 15 foot base width cut-off trench is shown on the design plans from Station 0+94 to Station 3+26 at the right abutment to the outlet conduit and at the spillway abutments extending from Station 11+30 to Station 14+00, except for the concrete ogee section which has a 6 foot deep concrete cut-off key instead of the compacted fill cut-off trench (see Plate 5 for additional details).

Grout Curtain - A grout curtain was installed beneath the cut-off trench with 1.5 inch grout holes 20 to 40 feet deep on 3 foot centers and 3 inch grout holes 60 feet deep on 60 foot centers. The grout curtain under the concrete cut-off key for the ogee was installed on 3 foot centers and 6 feet deep (see Plate 4 for the grout curtain profile).

Drains - A 3 foot thick sand and gravel drain blanket was provided beneath the downstream embankment exiting into the rock toe drain (the plan view of the drainage blanket and toe drain is shown on Plate 10 and a section through the embankment is shown on Plate 4).

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type -	Concrete ogee and chute channel
Width of Crest (feet) -	93
Crest Elevation (feet M.S.L.) -	1712.0
Gates -	None
Upstream Channel -	Forebay, slightly sloping toward center of reservoir, with a 2 foot thick impervious blanket overlying rock.
Downstream Channel -	The chute channel exits into an approximately 90 foot long stilling basin. A tailwater control structure (El. 1653.0 feet) is located an additional 150 feet downstream from the stilling basin. The outlet channel then joins the original streambed 640 feet downstream from the tailwater control structure (or 1160 feet downstream of the ogee crest).

j. Regulating Outlets - Water, for supply purposes, is drawn from the reservoir at three levels (El. 1700, 1688, and 1656 ft.) through gated valves which are manually operated from the valve house at the top of the intake riser. After entering various chambers in the riser tower, the water is discharged through the dam in a 24 inch diameter reinforced concrete pressure pipe. The reservoir can be drawndown by means of the 8 foot diameter cast-in-place reinforced concrete blow-off pipe controlled by a 4 foot diameter sluice gate which is also manually operated from the valve house. This 8 foot conduit extends 240 feet upstream from the riser tower and 416 feet downstream to the outlet structure. It was constructed in 41 16-foot sections with cut-off collars located at each joint.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Review of information included the Pennsylvania Department of Environmental Resources' (PennDER) file for this dam. Included in the file were:

1) A complete set of original design drawings.

2) Permit application report prepared by the Water and Power Resources Board of the Department of Forests and Waters (predecessor of PennDER).

3) "Foundation Investigation and Soil Exploration," dated July 1954, prepared by Dr. Louis Berger.

4) "Contract Documents for Construction of Tuna Creek Dam and Impounding Reservoir on West Branch of Tuna Creek for Bradford City Water Authority," dated March 1955, and prepared by Gannett Fleming Corddry and Carpenter, Inc.

5) Correspondence and semimonthly progress reports to PennDER during the construction period.

6) Inspection reports performed since 1957 and photographs of the dam.

The last inspection performed by PennDER personnel was on 15 September 1977. The only remedial measure necessary was the removal of trees along the spillway walls. Unfortunately, the complete file of the dam, including the engineer's design and construction file for the dam, was destroyed during a flood in Harrisburg in 1972.

2.2 CONSTRUCTION

Bradford City No. 5 Dam was designed by Gannett Fleming Corddry and Carpenter, Inc. of Harrisburg, Pennsylvania. The contractor was Buck and Donahue, Inc. of Newark, New Jersey. Construction of the dam commenced on 20 June 1955 and the final inspection of the construction was performed on 11 July 1957. Information contained in the semimonthly construction progress reports indicates that the contractor did not place any compacted fill or perform any weather sensitive construction during the winter months and wet periods. The pre-final inspection

report dated 21 June 1957 states that the dam was constructed according to the original design drawings except for two minor changes:

1) "Concrete was used for gutters instead of rock."

2) "Additional concrete was used in the footers at the entrance of the spillway."

Also, the progress reports noted changes in the bottom elevation of the ogee spillway and the addition of a tile drain at the east (right) abutment. The contractor reportedly placed 1050 cubic yards of Class B concrete fill under the ogee to replace the overexcavation necessary to reach sound rock. The extra tile drain was necessary to relieve seepage from a groundwater spring. The tile drain was installed from the spring location near the grout cap in the east abutment to an exit at the toe of the embankment.

2.3 OPERATION

The Bradford City Water Authority is responsible for maintenance and operation of the dam and appurtenant structures. Maintenance and pool records of a general nature are recorded and reported every year in the annual report for the water authority.

2.4 EVALUATION

a. Availability - The information reviewed consisted of PennDER's file on the dam and information obtained from the owner. Considering the unfortunate destruction of the design engineer's file for the dam, it is doubtful any additional information is available.

b. Adequacy - Review of structural stability calculations would have been desirable for this dam; however, under the circumstances, the readily available information and the results of the field inspection are considered adequate for the Phase I Inspection of the dam.

c. Validity - No indications were present during the field inspection to doubt the validity of the information reviewed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The dam and its appurtenant structures were found to be in good overall condition at the time of the inspection. No adverse weather conditions were present during the visual inspection on 8 November 1978. Noteworthy deficiencies observed are described briefly in the following paragraphs. The complete visual inspection check list and field sketch are given in Appendix A.

b. Dam - Several holes were observed downstream of the rock toe drain to the left of the center of the dam (see field sketch). Most of these holes were approximately 2 foot by 2 foot in plan view and 18 inches deep. However, a few of these holes were deeper, and one measured 6 feet deep. These deeper holes had water standing in them up to 1 foot below the ground surface in the area. The exact cause of these holes could not be determined; however, there are several possible explanations for them: 1) they originally may have been animal dens, i.e., fox or rabbit, which were later abandoned because of water flooding them, 2) they may be sinkholes formed from surface runoff percolating through the waste fill and into the rock toe drain, or 3) they may be sinkholes formed due to the 4 inch clay pipe drain becoming disjointed, broken, or possibly not being outletted properly when constructed.

Seepage was observed exiting the ground approximately 200 feet downstream from the toe near this area. This seepage may be coming from the drainpipe noted at the left end of the toe drain or possibly from underseepage below the dam. The seepage was clear and flowing at an estimated rate of 20 g.p.m. on 16 June 1979.

The drain located at the left end of the toe drain was flowing 3 inches deep in a 4 inch diameter clay pipe. This drain is not shown on the design plans nor was it noted in the correspondence in PennDER's file for the dam. The source of the flow is therefore not known; however, the pipe appears to be coming from along the junction of the embankment and the in situ knoll. (Note: The spillway is also in this general direction.) The flow from the drain after exiting into a small 2 foot by 2 foot basin then re-enters a 4 inch

diameter pipe. The general direction of this pipe is pointed away from the basin at an approximately 60 degree angle to the centerline of the dam. The outlet of the pipe could not be located; however, it may coincide with the location of the observed flow (note number 8 on the field sketch) below the dam.

An estimated rate of flow of 1 g.p.m. of clear seepage was exiting from the in situ knoll near the spillway chute channel approximately 200 feet downstream of the centerline of the dam. This flow could then be observed exiting the riprap to the right of the end of the stilling basin training wall.

Groundwater or seepage was observed exiting the rock riprap behind the right wing wall of the outlet conduit outlet structure. This clear seepage was observed to be flowing at an estimated rate of 2 to 3 g.p.m. on 8 November 1978 and approximately 5 g.p.m. on 16 June 1979. The source of the water could not be determined during the inspection.

However, a possible source of this seepage could be a tile drain installed in the right abutment area near the grout cap to relieve seepage from a groundwater spring. The resident engineer during construction noted that the tile drain was extended below the toe of the dam. However, there is no plan drawing showing the exact location of the drain nor was a drain outlet located on the right side of the dam during the visual inspection. Therefore, it is the opinion of the inspector that the seepage was either natural groundwater exiting at this location or else the flow from this tile drain installed during construction.

A disjointed pipe was observed on the right hillside approximately 150 feet below the dam and below the access road. This pipe reportedly served as the outlet for the surface runoff catch basin on the right abutment.

Trees and shrubs were observed growing in the rock toe drain and the downstream area near the center of the dam. Also, several rodent holes were observed in the downstream embankment. The approximate locations of the trees and rodent holes are shown on the field sketch.

c. Appurtenant Structures - Overall, the spillway was in good condition; however, some cracking and

leaching of the concrete has occurred at several places in the spillway chute channel. Also, the joint filler is missing from some of the joints. The joint between the observation deck (referred to as a "bullnose" in the correspondence file) retaining wall and the adjacent spillway training wall is one of the joints in particular that needs to be repaired. At the time of inspection (8 November 1978) some minor debris was present in the chute channel; however, this debris was not present on 16 June 1979 during a site visit.

At the time of inspection, no flow was being discharged through the outlet conduit; therefore, the inspection team was able to walk up into the conduit and inspect its condition. Overall, the conduit was in very good condition; however, at several locations the concrete on the soffit of the conduit was spalled and the reinforcing bars exposed. Also, some debris was present in the discharge channel of the outlet conduit.

At the present time, only a hole chipped through the concrete on the right side of the observation deck allows the surface drainage to escape. Also around the edges of the structure, the backfill has settled and is lower than the center of the fill.

d. Reservoir Area - The side slopes of the reservoir are steep but with good vegetative cover. No unusual sedimentation was observed in the reservoir.

e. Downstream Channel - The dam and reservoir are located near the headwaters of the West Branch of Tunungwant Creek. The outline of the original streambed under the dam is shown on the field sketch. Below the dam the channels from the outlet conduit and spillway join together with the original streambed. Two homes are located in low-lying areas approximately 3000 feet downstream of the dam. An additional 10 homes are located along the stream before the confluence of the West Branch of Tunungwant Creek and Marilla Brook 4 miles below the dam. The confluence of the West and East Branches of Tunungwant Creek is an additional 2 miles downstream. The city of Bradford (1970 census population 12,672) is approximately 5 miles below the dam.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no formal written procedures for emergency operation or downstream evacuation in the event of impending catastrophe. It is recommended that formal emergency procedures be prepared, prominently displayed, and furnished to the operating personnel.

4.2 MAINTENANCE OF DAM

The Bradford City Water Authority is responsible for maintenance of the dam. Generally, the maintenance procedures of the water authority are considered adequate; however, formal maintenance procedures should be developed. In addition to the present maintenance procedures, the following items should be implemented:

1) A rodent control program.

2) Formal inspection procedures, including periodic inspection of the underwater structures.

4.3 MAINTENANCE OF OPERATING FACILITIES

The sluice gates are operated twice a year to insure operational adequacy. These operational checks should continue in the future with proper records kept in the owner's file. The records should include information concerning the maintenance and remedial work performed on the dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or procedure in the event of a dam failure. An emergency warning procedure should be developed.

4.5 EVALUATION OF OPERATIONAL ADEQUACY

The operational facilities of the dam are considered adequate.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - There were no hydrologic and hydraulic design calculations available for review and evaluation as part of this Phase I Investigation. Storage and discharge rating curves are included in the design plans and are utilized in the analysis outlined in paragraph 5.1.d.

b. Experience Data - According to the owners of the dam, the maximum reservoir level was approximately 6 inches above the normal pool El. of 1712.0 feet. Daily records of the reservoir level are maintained by the Bradford City Water Authority.

c. Visual Observations - At the time of the inspection, no condition was observed that would seriously affect the ability of the spillway or outlet works to operate satisfactorily in the event of a flood.

d. Overtopping Potential - Bradford City No. 5 Dam is classified as a "High" hazard-"Intermediate" size dam requiring evaluation for a spillway design flood (SDF) equal to the Probable Maximum Flood (PMF). The hydrologic and hydraulic capabilities of the reservoir and spillway were evaluated by routing the PMF through the reservoir with the aid of the U.S. Army Corps of Engineers' Flood Hydrograph Package, HEC-1. The PMF hydrograph developed as part of this analysis had a peak discharge of 9070 c.f.s. based on a 6-hour rainfall of 21.3 inches. The results of the flood routing indicate that the reservoir is capable of passing the PMF with a corresponding maximum reservoir level of El. 1720.2 feet or approximately 2.8 feet below the crest elevation of 1723.0 feet.

e. Spillway Adequacy - The dam, as outlined in the above analysis, is capable of passing the PMF without overtopping. Therefore, the spillway is classified as "adequate" according to the recommended criteria.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The cause of the vertical holes downstream of the rock toe drain should be determined by a detailed investigation in this area. The investigation should develop recommendations for the remedial work which will be necessary to correct the cause of these holes and repair the area. These holes and the probable cause or causes (see paragraph 3.1.b.) are not considered adverse to the structural stability and safety of the dam at the present time. However, the investigation should include the inspection of the 4 inch clay tile drainpipe located in the area and the cause of the observed seepage exiting the ground surface (item 8 on the field sketch) 200 feet downstream from the area.

The observed seepage exiting from the in situ knoll (item 3 on the field sketch) should be periodically examined in the future to verify that the quantity of seepage is not increasing and transportation of fine material is not occurring. Should the extent of the seepage significantly increase with time, the condition should be studied in detail and appropriate remedial measures taken.

The seepage exiting from behind the right wing wall of the outlet conduit structure (item 2 on the field sketch) should be examined frequently in the future to verify that the quantity of seepage is not increasing and transportation of fine material is not occurring. A seepage weir should be installed to monitor the rate of flow. The turbidity of the flow should also be measured and recorded. It is recommended that the outlet pipe for the catch basin adjacent to the access road on the right abutment be repaired and the discharge outletted downstream from the head wall. Additionally, it is recommended that the concrete gutter, or possibly a pipe, (item 11 of the field sketch) on the right side of the dam be extended to discharge downstream from the outlet head wall. Should the extent of the seepage area or characteristics of the seepage increase with time, the condition should be studied in detail and appropriate remedial measures taken.

b. Design and Construction Data - Since the original designer could not provide their computations, a stability check was performed on a cross-section of the ogee section of the spillway (see Appendix F). The stability computations were made in accordance with "Gravity Dam Design," U.S. Army Corps of Engineers, Manual EM 1110-2-2200, 25 September 1958 (including change 2) and ETL 1110-2-184, 25 February 1974.

Stability analyses were completed for the following cases:

I. P.M.F. condition (El. 1720.2 feet) no ice load - tailwater at El. 1664.6 feet.

II. Water level at normal pool (El. 1712.0 feet) with ice load - tailwater at El. 1653.0 feet.

It should be noted that the ogee section stability is not influenced by the tailwater (El. 1664.6 feet maximum) because the spillway chute channel carries the discharge well below the toe of the ogee section (El. 1694± feet). Also, for purposes of checking the stability, the design base elevation (El. 1694.0 feet) of the ogee section was used in the calculations. However, during construction, the base elevation of the ogee section was lowered 5 to 10 feet to reach sound bedrock. This increased the factor of safety for the structure, because of the increased base width and passive resistance at the toe and probable reduction in percentage of total head for the uplift pressure at the heel of the section.

The results of the stability analyses show the resultant force is within the middle one-third of the base and the minimum factor of safety of 211 against sliding is well above the recommended value of 4.

Calculations of embankment slope and foundation stability were not available for review. General experience with slopes of heights, inclinations, materials, and hydraulic conditions similar to those of the dam slopes indicates that these slopes could be shown to satisfy the stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." This inference is supported by empirical guidelines on stable slope inclinations given by the U.S. Bureau of Reclamation (1973) Design of Small Dams, 2nd edition, pages 261-267.

In view of the inclinations of the dam slopes, their history of satisfactory performance, the provision for the filter drain blanket and toe drain, and the fact that no indications of instability or wetness on the embankments were observed during the field inspections of 8 November 1978 and 16 June 1979; no further stability assessments are necessary for this Phase I Inspection Report.

c. Operating Records - Nothing in the readily available operating information indicates cause for concern relative to the structural stability of the dam.

d. Post-Construction Changes - There have been no post-construction changes to the dam which affect the structural stability.

e. Seismic Stability - The dam is located near the boundary between Zones 1 and 2 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." Both of these zones are considered to present no hazard from earthquakes provided static stability conditions are satisfied and conventional safety margins exist. As indicated in paragraph 6.1.b., Bradford City No. 5 Dam could be shown to meet the static stability requirements of the "Recommended Guidelines for Safety Inspection of Dams." Therefore, further consideration of the seismic stability is not warranted.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - Overall, the dam was found to be in good condition at the time of inspection. Bradford City No. 5 Dam is a "High" hazard-"Intermediate" size dam requiring a spillway capacity equal to the PMF. As presented in Section 5, the spillway and reservoir are adequate to pass the PMF without overtopping the dam.

The stability of the ogee section spillway of Bradford City No. 5 Dam meets the criteria required by the "Recommended Guidelines for Safety Inspection of Dams" for normal load with ice load and during the PMF. Also, the embankment could be shown to meet the stability criteria required and no observations of instability (i.e., tension cracks or seepage) were observed during the visual inspection of the embankment. However, several locations of seepage and the presence of the vertical holes downstream from the embankment should be investigated in more detail as recommended in paragraph 7.1.d.

b. Adequacy of Information - The information available and the observations and measurements made during the field inspection are considered sufficient for this Phase I Inspection Report.

c. Urgency - The owner should initiate the action discussed in paragraph 7.2 without delay.

d. Necessity for Additional Data/Evaluation - The owner should have a qualified professional engineer investigate in detail the cause of the vertical holes downstream from the toe drain of the embankment. The condition of the 4 inch tile drain and the cause of the seepage exiting near this area should be a part of this detailed investigation. This investigation should result in recommendations as necessary to correct the cause and condition of the holes.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed a few items of remedial work which should be performed without delay by the owner. These include:

1) The owner should have a qualified professional engineer investigate, in detail, the cause of the vertical holes downstream from the toe drain of the embankment. Also, the condition of the 4 inch tile drain and the cause of the seepage exiting near this area should be evaluated as a part of the investigation.

2) Periodically examine the seepage exiting from the left side of the in situ knoll near the spillway chute channel. Should the quantity of seepage or turbidity significantly increase with time, the condition should be studied in detail and appropriate remedial measures taken.

3) Install a seepage weir to monitor the rate of flow from behind the right wing wall of the outlet conduit head wall structure. This weir should be checked frequently for rate of flow and turbidity, and the measurements should be recorded. If the results of the measurements indicate a change in quantity or turbidity of the flow, appropriate action should be taken.

4) The outlet pipe for the catch basin on the right abutment (to the right of the access road) should be repaired and extended below the outlet conduit head wall structure. This repair may help to decrease the volume of flow exiting near the outlet structure.

5) The drainage gutter should be extended below the outlet head wall structure, or a pipe should be installed to carry the flow downstream of the outlet structure. This modification may also help to reduce the volume of flow exiting near the outlet structure.

6) Remove the trees and brush presently growing in the toe drain and immediately downstream of the toe drain (within 50 feet).

7) Repair the animal burrows in the embankment and establish a rodent control program.

8) Where necessary, replace the joint filler in the spillway and other appurtenant structures.

9) Repair the spalled concrete in the outlet conduit.

10) Remove the debris from the outlet channels and continue to remove it in the future, when necessary.

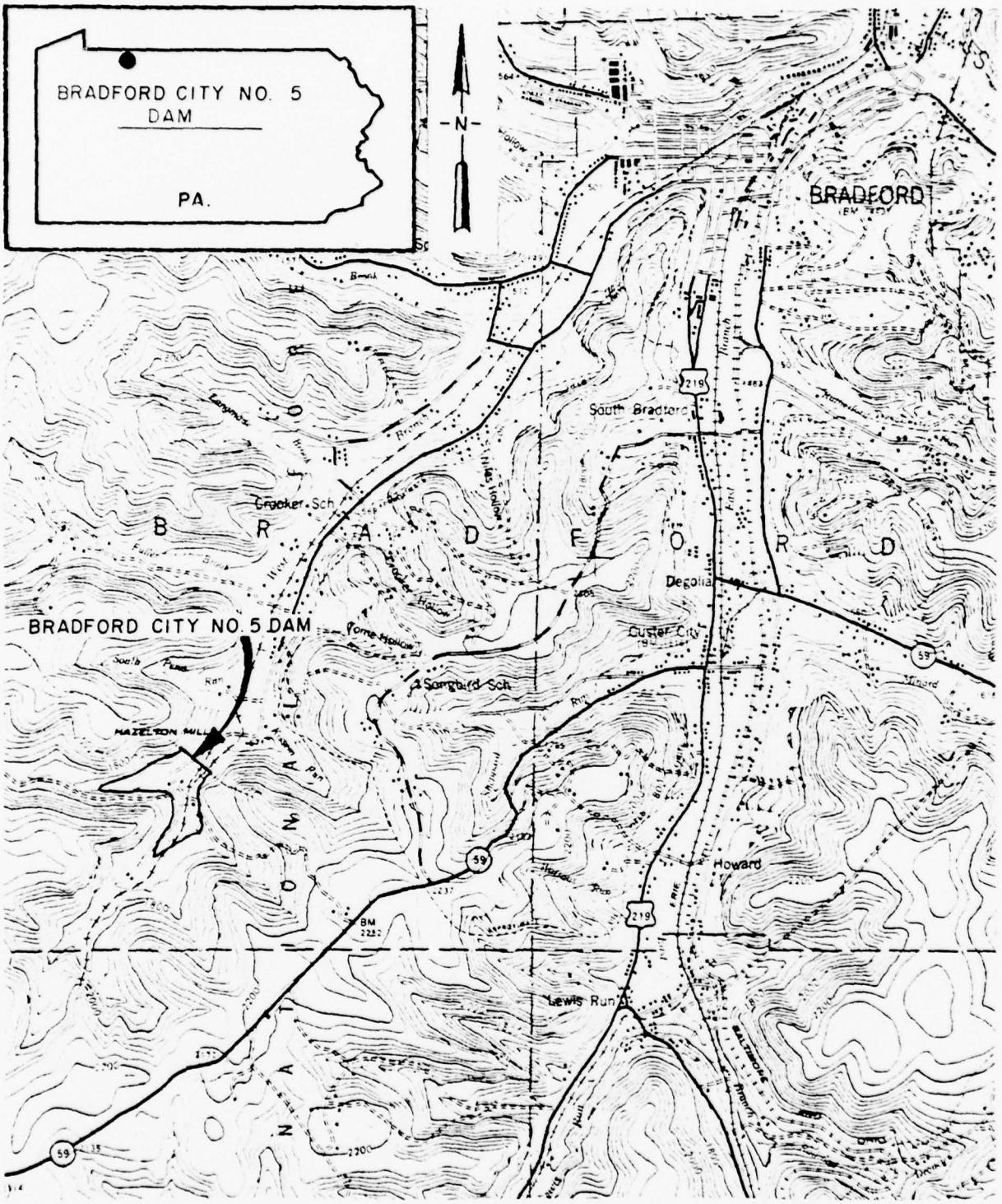
In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

PLATES



1 0 1 2 3 4 MILES

1000 0 1000 2000 3000 4000 5000 6000 7000 YARDS

1000 0 3000 6000 9000 12000 15000 18000 FEET

1 0 1 2 3 4 5 KILOMETERS

PLATE I LOCATION PLAN

BRADFORD CITY NO. 5 DAM

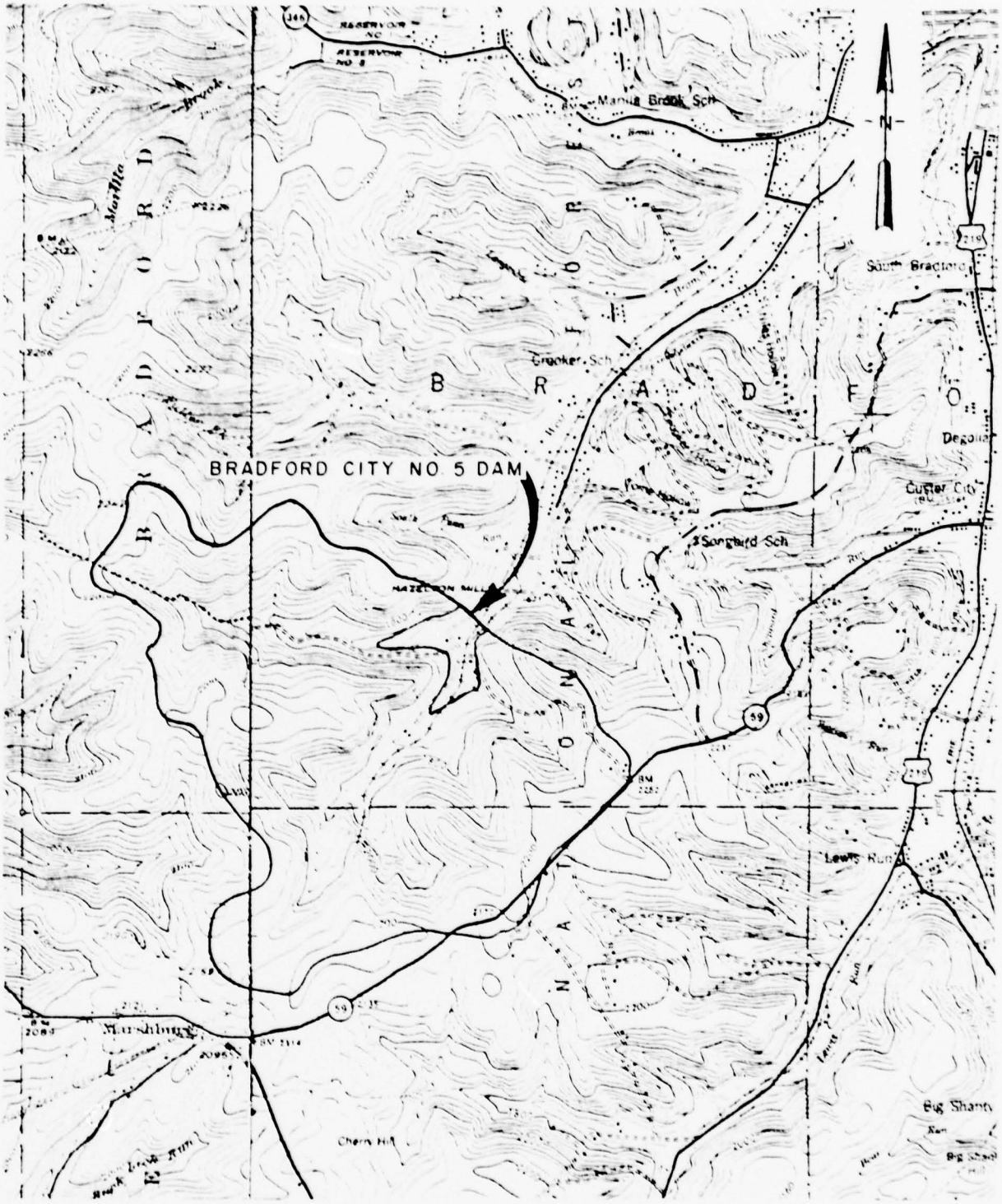
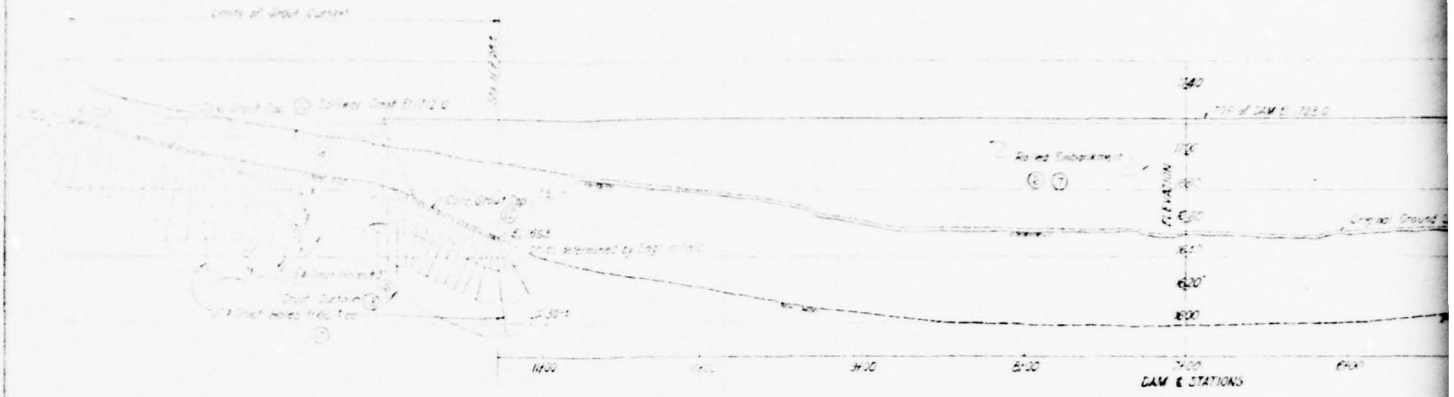


PLATE 2 WATERSHED MAP

BRADFORD CITY NO. 5 DAM


Tuna Creek
West Branch
TAILWATER CONTROL STRUCTURE
OUTLET CHANNEL
Sta 7+90.305
Dumped Riprap on 6 Grout
Disposal Area to be directed by the Engineer
ROCK TOE
Intercepting Gutter
STILLING BASIN
EL 1642
EL 1725
Crest Length 930'
No cut & no fill
Limits of 2' thick selected impervious blanket in overlay area
1650
1660
1670
1680
1690
1700
1710
1720
1730
1740

West Branch Tuna Creek
Disposal Area to be directed by the Engineer
Intercepting Gutter
Drainage Ditch
ROCK TOE
1650
1660
1670
1680
1690
1700
1710
1720
1730
1740
GENERAL NOTES
1. Section indicates that Section C was taken on Sheet No. 8 and is shown on Sheet No. 13.
2. The payment items for work shown appear on detail sheets.
3. For control and stationing, see Sheet No. 5.
PLATE 3
TUNA CREEK PROJECT
DAM AND RESERVOIR
GENERAL PLAN
2162
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
SCALE 1"=40'
Note Approx Half Scale



PROFILE ALONG ℄ DAM
SCALE 1"=40'

SECTION (E.A. 1)
SECTION (E.A. 2)
SCALE 1"=20'

DETAIL - TOP OF DAM

GENERAL NOTES

1- Each no. (1) indicates [illegible]

2- Numbers in the [illegible]

3- All [illegible]

4- All stationing [illegible]

Note : Approx. Half Scale

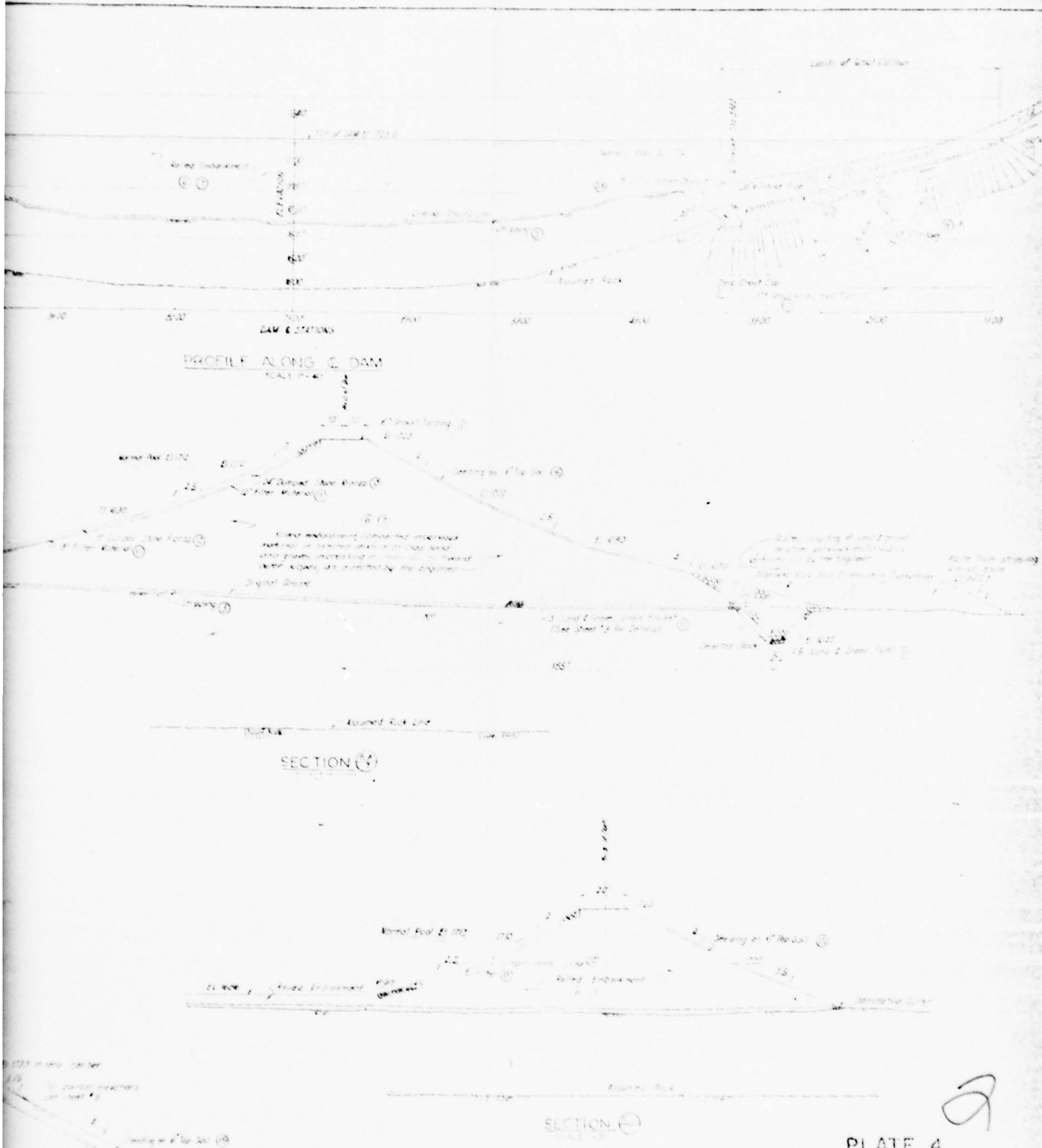


PLATE 4

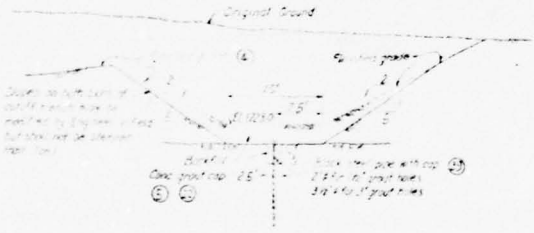
MLO	TUNA CREEK PROJECT	7
MLO	DAM AND RESERVOIR	
CYL	EMBANKMENT	2352
	Sections and Details	
	BRADFORD CITY WATER AUTHORITY	
	GANNETT FLEMING CORDDRY & CARPENTER, INC. ENGINEERS	
	600 N. SECOND ST. HARRISBURG, PENNA.	

GENERAL NOTES

Note: Approx. Half Scale.

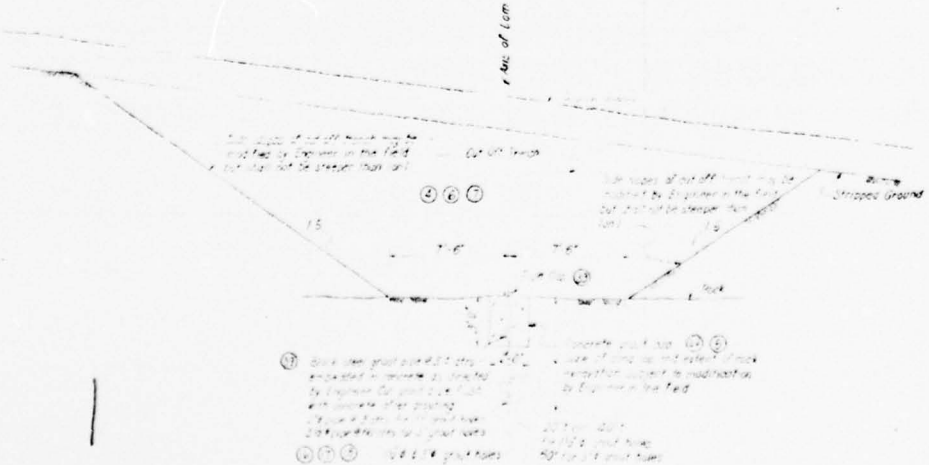
CUT-OFF TRENCH

SCALE 1"=40'



SECTION

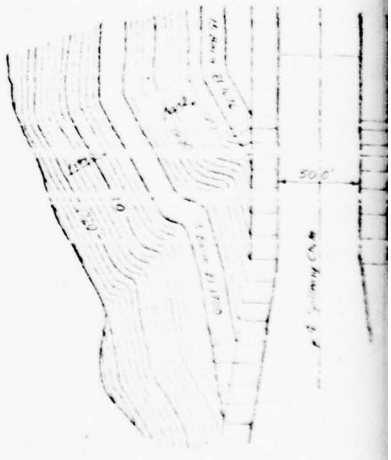
SCALE 1"=10'



TYPICAL SECTION

CUT-OFF TRENCH & GROUTING

SCALE 1"=10'



SPILLWAY CHANNEL

SCALE 1"=40'

Note: Approx. Half Sc

UT - OFF TRENCH
SCALE 1"=40'

CAMBER AT TOP OF DAM
SCALE HOR. 1"=50'
VERT. 1"=5'

SPILLWAY CHANNEL PLAN
SCALE 1"=40'

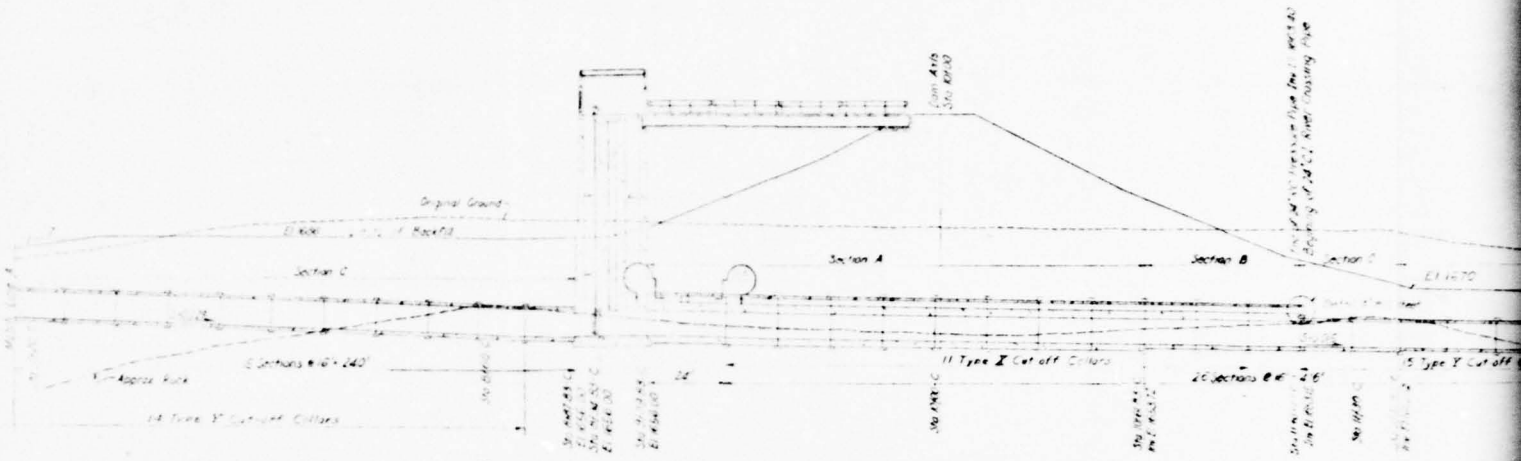
2

PLATE 5

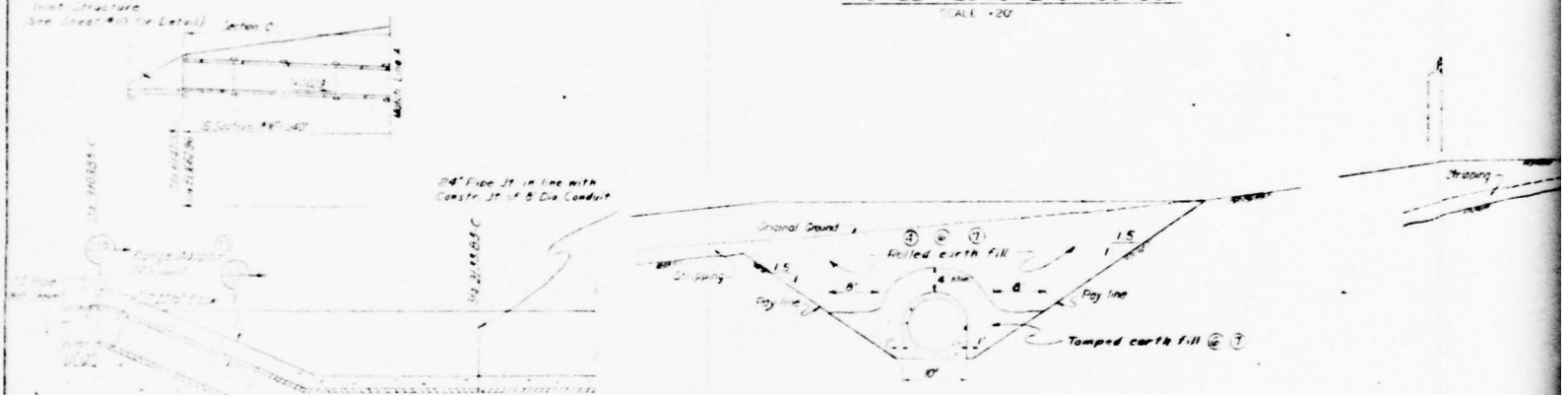
DSN. CYL	TUNK CREEK PROJECT	SHEET NO. 6
DET. WLC	DAM AND RESERVOIR	JOB NO. 2162
CK'D. CYL	EMBANKMENT	DATE MAR. 19
APPROVED	SCRANTON CITY WATER AUTHORITY	

KRAUTH FLEMING COSGRIFF & CARPENTER, INC.
ENGINEERS
400 N. SECOND ST. HARRISBURG, PENNA.

Note: Approx. Half Scale



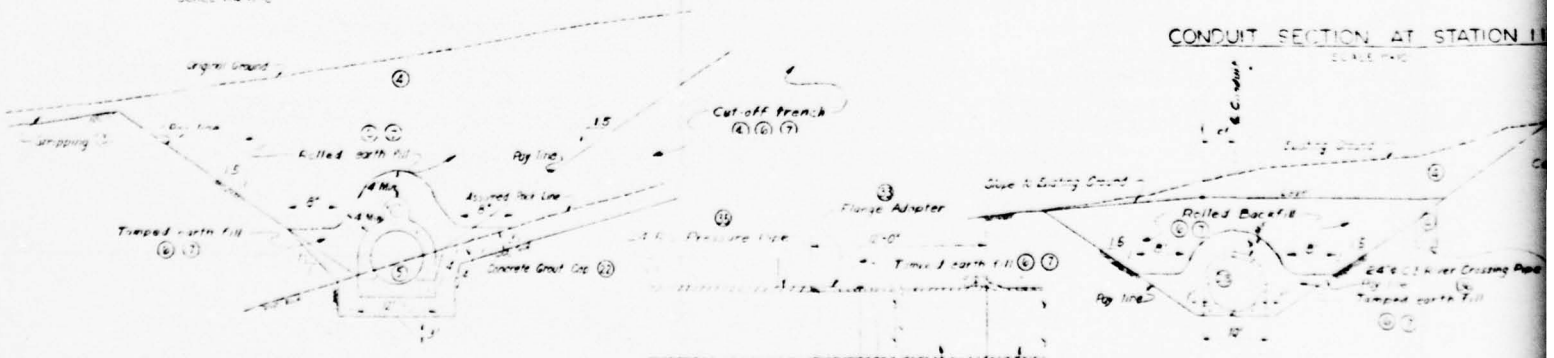
PROFILE ALONG ℄ OF CONDUIT
SCALE 1"=20'



CONDUIT SECTION AT STATION 7/20-C
SCALE 1"=10'

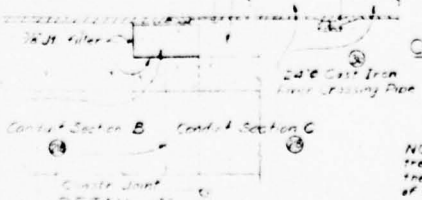
SECTION
SCALE 1"=10'

CONDUIT SECTION AT STATION 11
SCALE 1"=10'



CONDUIT SECTION AT STATION 10/00-C
SCALE 1"=10'

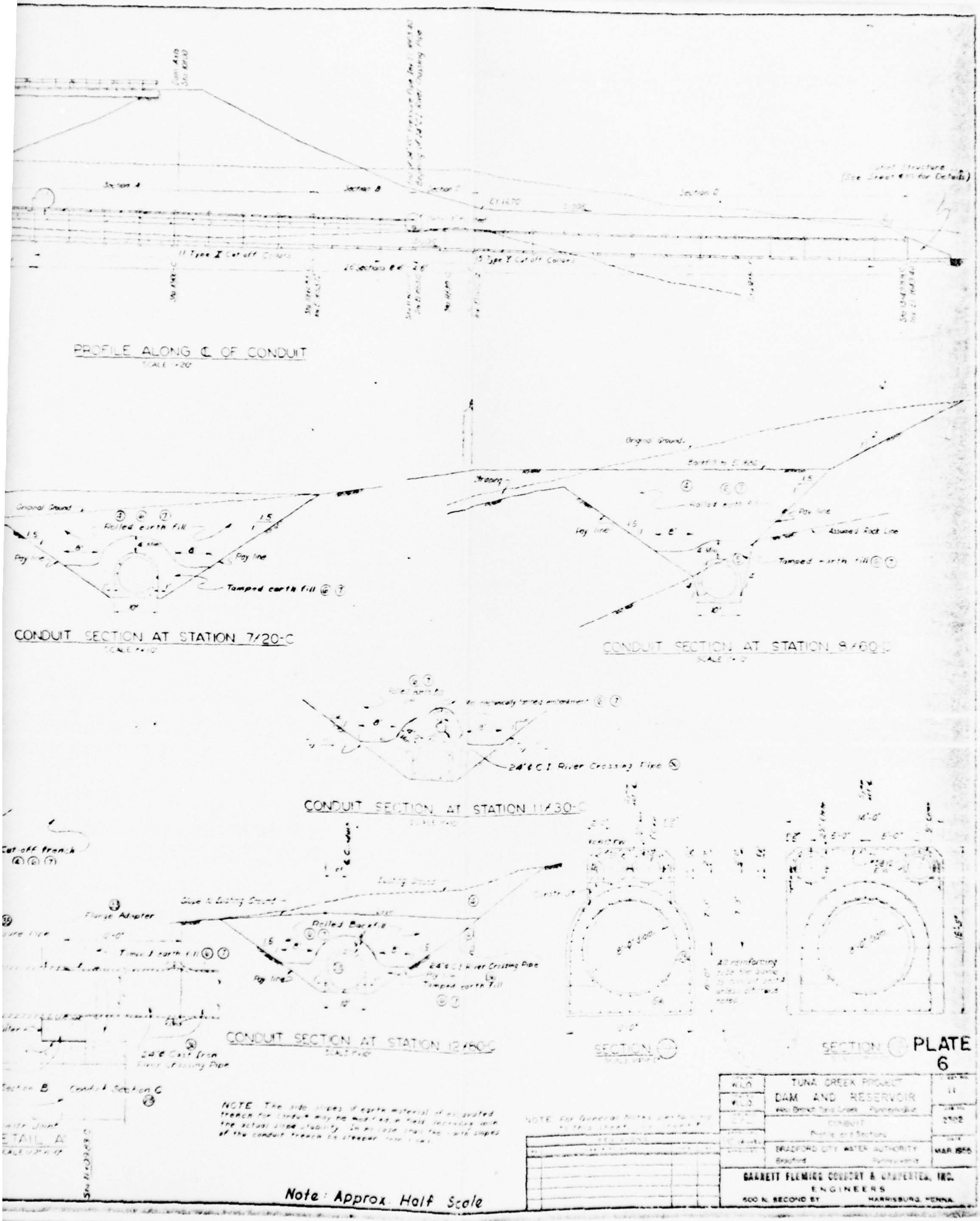
CONDUIT SECTION AT STATION 12/80-C
SCALE 1"=10'



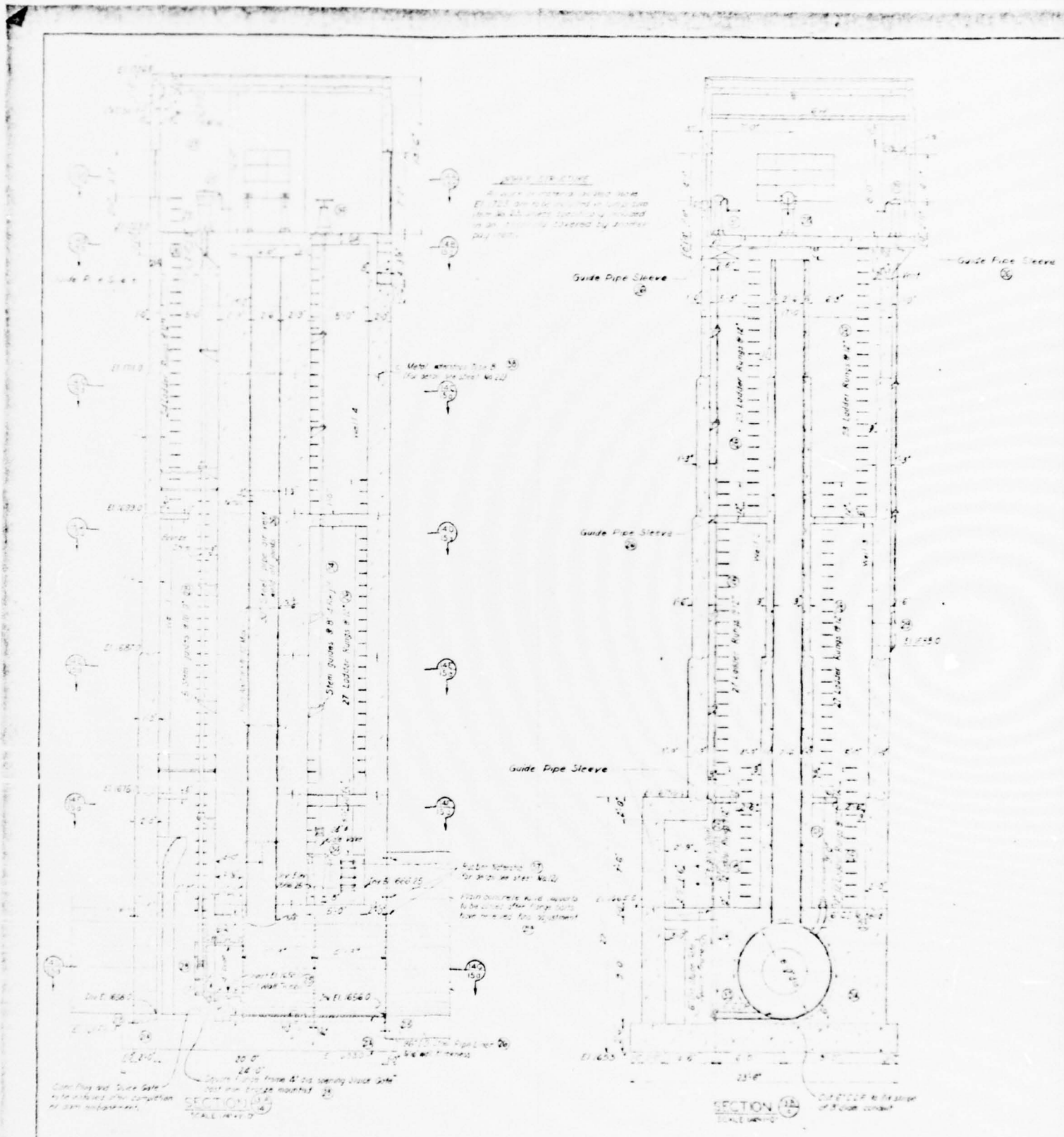
DETAIL 'A'
SCALE 1"=1'-0"

NOTE The side slopes of earth material of excavated trench for conduit may be modified in field to conform with the actual slope stability. In no case shall the side slopes of the conduit trench be steeper than 1:1.

Note: Approx. Half Scale

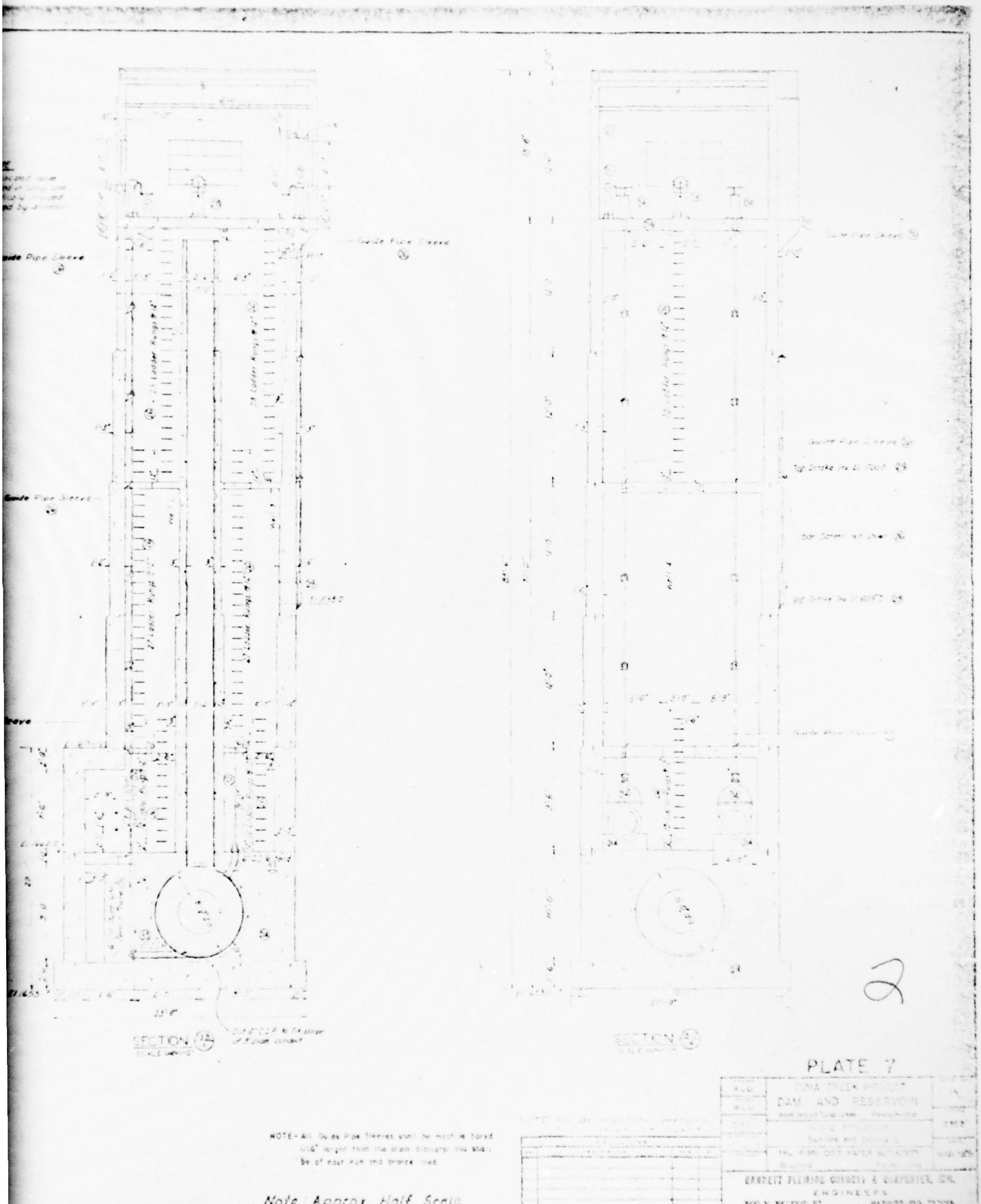


PROFILE ALONG ℄ OF CONDUIT
11 Type I Cut off Collars
15 Type I Cut off Collars
Section A
Section B
Section C
Section D
Outlet Structure (See Sheet for Details)
Original Ground
Rolled earth fill
Pay line
Tamped earth fill
CONDUIT SECTION AT STATION 7+20-C
Stripping
Assumed Rock Line
CONDUIT SECTION AT STATION 8+60-C
24"⌀ C.I. River Crossing Pipe
CONDUIT SECTION AT STATION 11+30-C
Cut-off trench
Flange Adapter
Slope to Existing Ground
Rolled Backfill
24"⌀ C.I. River Crossing Pipe
Tamped earth fill
24"⌀ Cast Iron River Crossing Pipe
CONDUIT SECTION AT STATION 12+80-C
All reinforcing to be the same as conduit section unless otherwise noted.
SECTION
SECTION
DETAIL A
NOTE: The side slopes of earth material of excavated trench for conduit may be modified in field, depending upon the actual slope stability. In no case shall the earth slopes of the conduit trench be steeper than 1 on 1.
PLATE 6
TUNA CREEK PROJECT
DAM AND RESERVOIR
West Branch Tuna Creek — Pennsylvania
CONDUIT
Profile and Sections
BRADFORD CITY WATER AUTHORITY
Bradford — Pennsylvania
MAR 1955
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
500 N. SECOND ST — HARRISBURG, PENNA.
Note: Approx. Half Scale

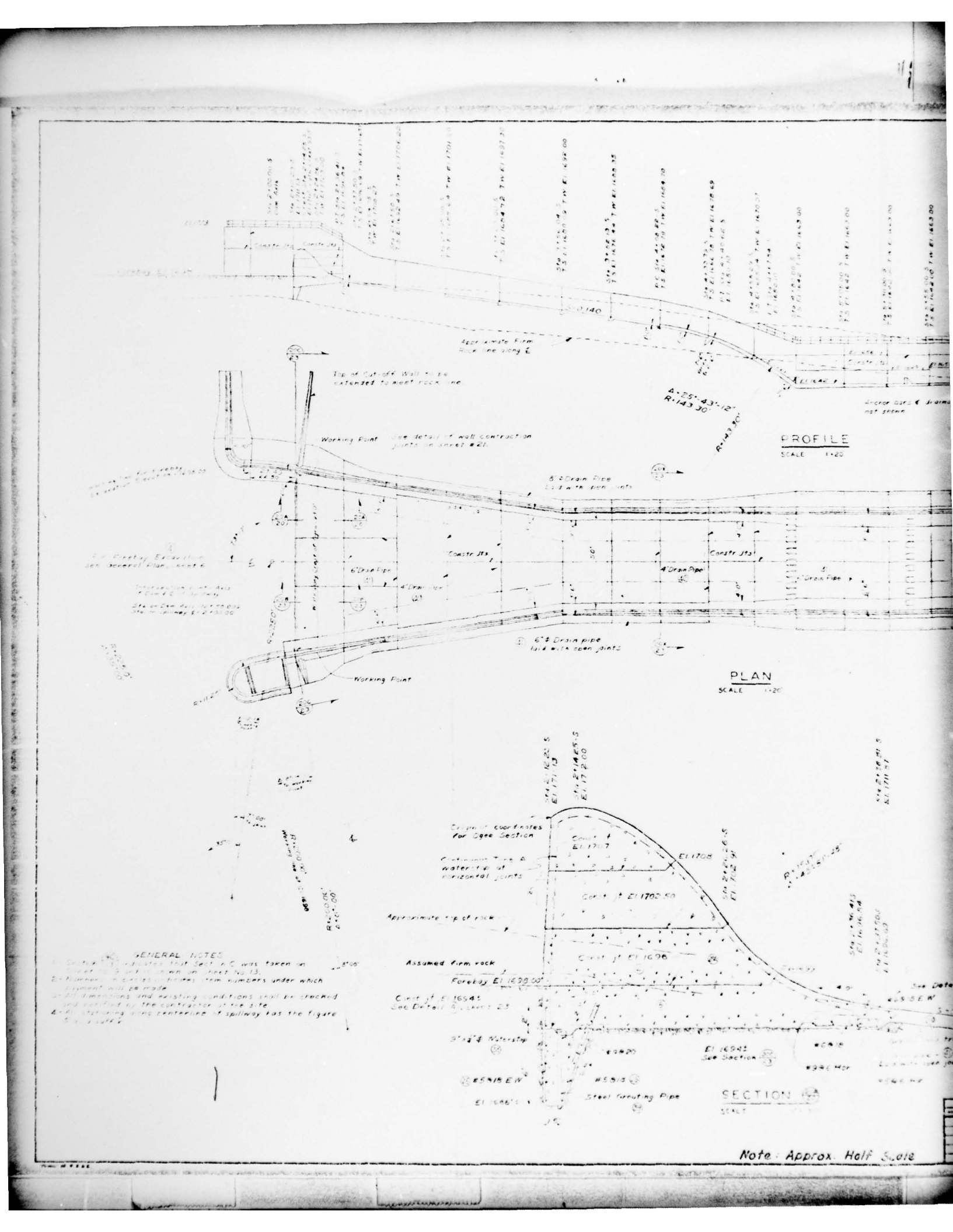


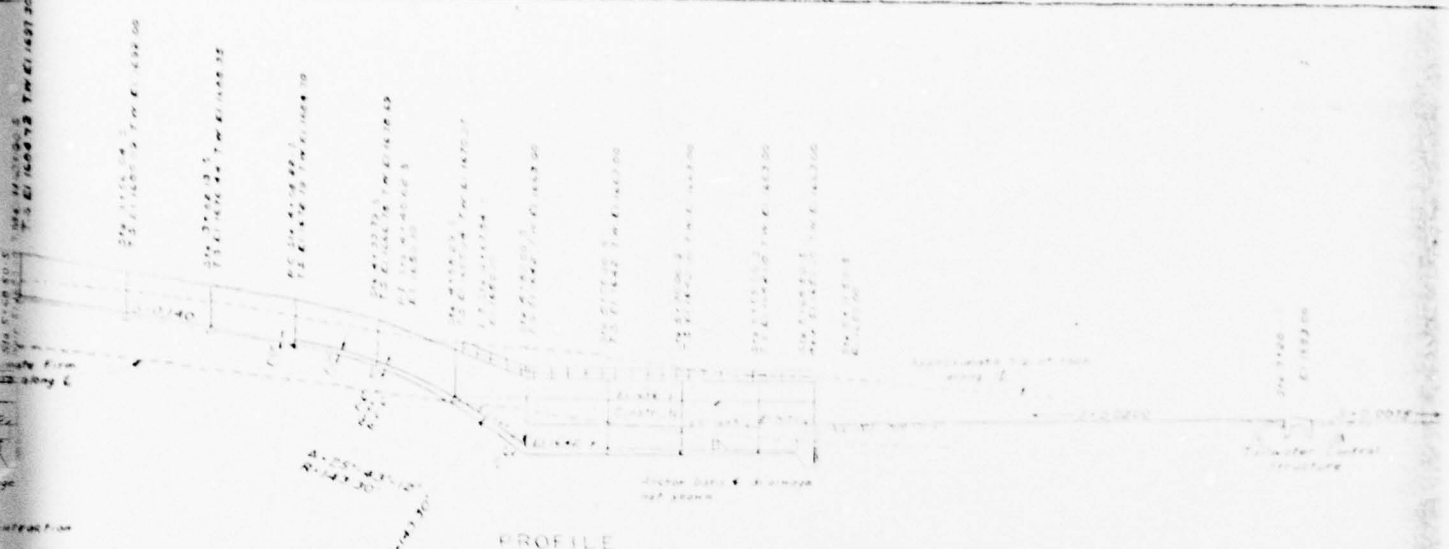
NOTE - All Guide Pipe Sleeves shall be made of steel pipe 1/16" larger than the stem diameter and shall be of cast iron and bronze mat

Note: Approx Half Scale

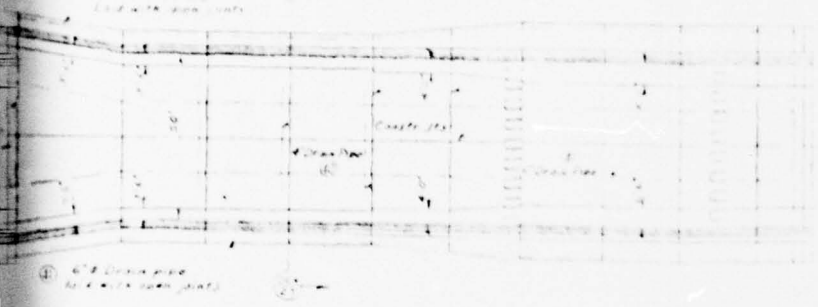


Guide Pipe Sleeve
Ladder Rungs
SECTION
PLATE 7
TUNA CREEK PROJECT
DAM AND RESERVOIR
GANNETT FLEMING CORDDRY & CARPENTER, INC.
ENGINEERS
600 N. SECOND ST.
HARRISBURG, PENNA.
NOTE - All Guide Pipe Sleeves shall be machine bored 1/16" larger than the stem diameter and shall be of cast iron and bronze lined.
Note: Approx Half Scale


PROFILE
SCALE 1:20
PLAN
SCALE 1:20
SECTION
Working Point
Top of Cut-off Wall to be extended to sheet rock line
Assumed firm rock
Approximate top of rock
Foreday El. 1638.00
Steel Grouting Pipe
Note: Approx. Half Scale

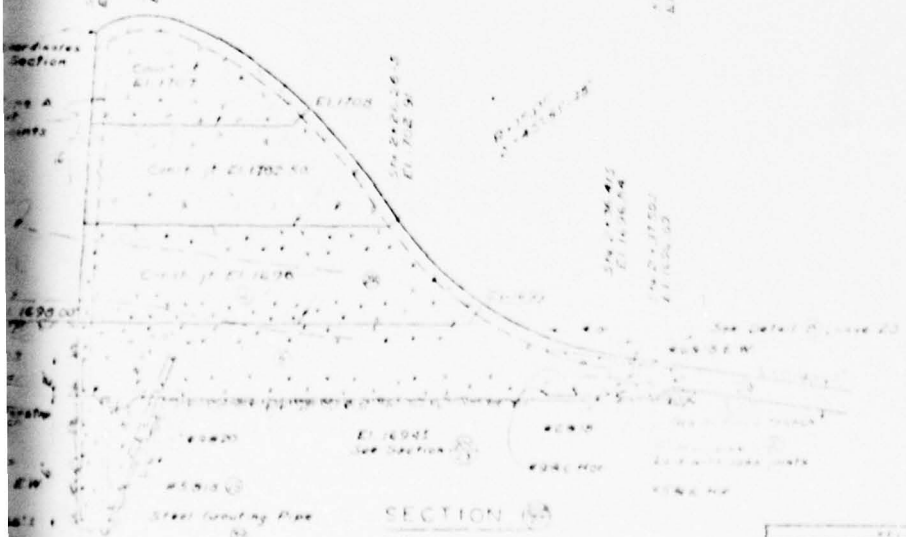


PROFILE



PLAN

COORDINATES OF THE OGEE PROFILE



SECTION

Note: Approx Half Scale

PLATE 8

TUNA CREEK PROJECT
DAM AND RESERVOIR

SPILLWAY

SALEM CITY WATER AUTHORITY

LAWRENCE FLEMING CORDUKE & CARPENTER INC.
ENGINEERS

OUTLET CHANNEL
TAILWATER CONTROL WEIR
STA 6+45.00 S
STA 5+71.50 S
STA 7+20.01 S
NO 34
NO 33
NO 32
NO 31
NO 30
NO 29
NO 28
NO 27
DRAIN TRENCH
NO 26
NO 24
NO 22
NO 14
NO 11
NO 10
NO 17
NO 21
NO 19
SPILLWAY
TEST PIT
DAM AXIS STA 12+50.00
SPILLWAY STA 2+00.00 S
OUTLET
P.T. STA 12+77.69 P
P.C. STA 12+41.85 P
Δ= 30°20'
T= 43.02
R= 158.69
L= 84.02
Δ= 45°
T= 63.64
R= 153.6
INTAKE STRUCT
INLET
1650
1675
1700
1725
1750
1775
LEGEND
○ 3" (NX) CORE HOLES
● 6" AUGER HOLES TO BOULDERS OR ROCK

NOTE ON CURVE DATA

Wherever degree of curvature is quoted for an these sheets, the arc definition is understood

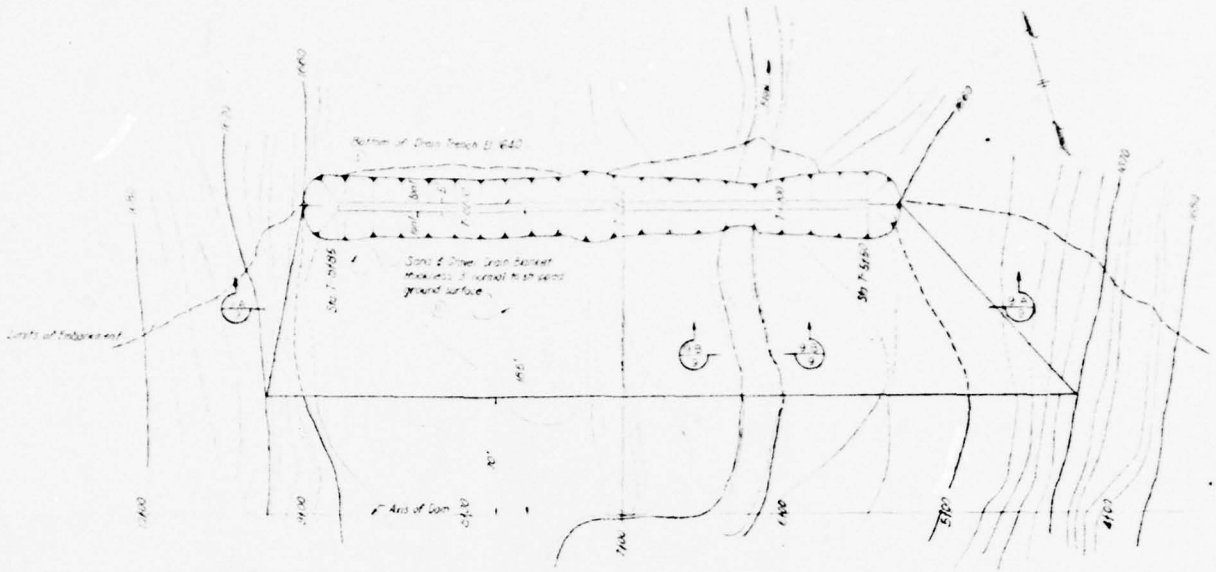
LEGEND

Sta 0+00 - Start of stationing along axis of Dam
Sta 0+100 - Start of stationing along centerline of Outlet Works
Sta 11+09.83 P - Start of stationing along centerline of Pipe
Sta 0+00 S - Start of stationing along centerline of Spillway
Sta 5+00 T - Start of stationing along centerline of Trench

PLATE 9

W.L.O.	TUNA CREEK PROJECT	SHEET NO.
W.L.O.	DAM AND RESERVOIR	3
A.C.H.	FOUNDATION EXPLORATION PLAN	JOB NO. 238*
	PROVIDENCE CITY WATER AUTHORITY	MAP FILE
	Providence Pennsylvania	
GANNETT FLEMING CORDRY & CARPENTER, INC. ENGINEERS		
6000 N. SECOND ST.	HARRISBURG, PENNA.	

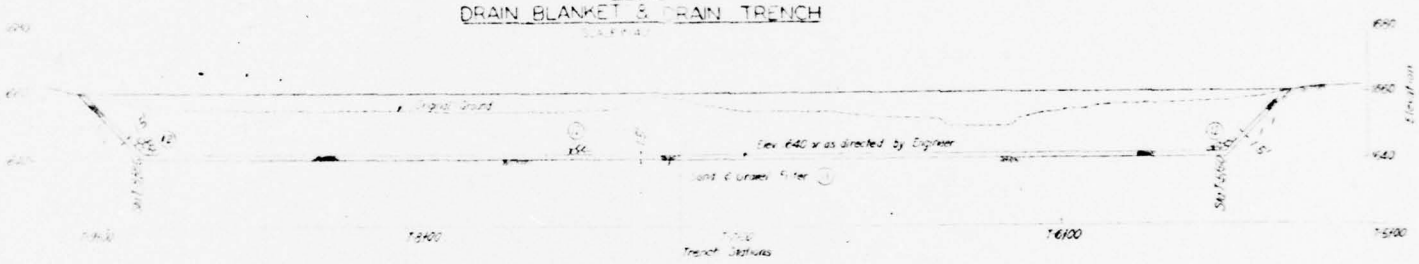
Note - Approx. Half Scale



PLAN

DRAIN BLANKET & DRAIN TRENCH

SCALE 1"=100'

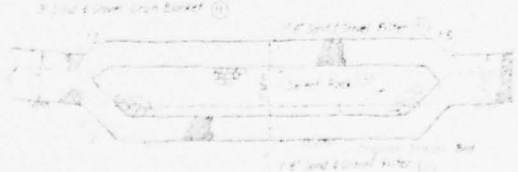


PROFILE-DRAIN TRENCH

SCALE 1"=20'

SECTION (4A)

SCALE 1"=20'

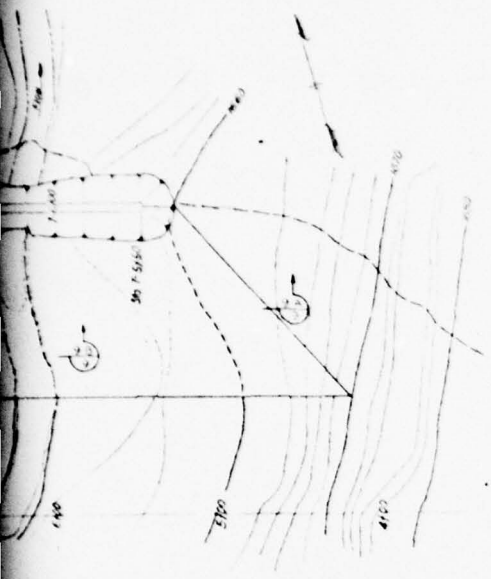


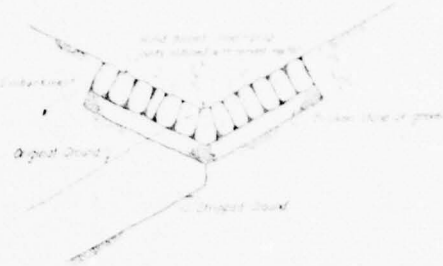
SECTION (3)

SCALE 1"=20'

TYPICAL SAND AND GRAVEL FILTER

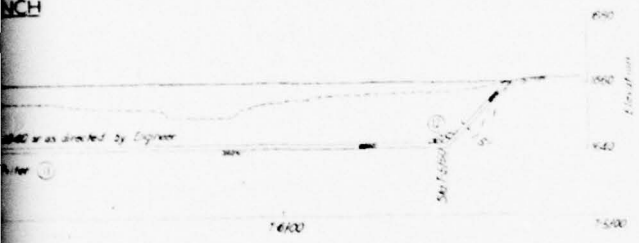
SCALE 1"=10'





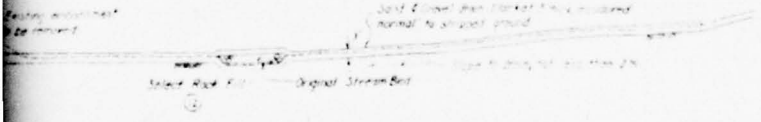
DETAIL
INTERCEPTING GUTTER

NCH



TRENCH

SECTION



TYPICAL SAND AND GRAVEL FILTER

2

PLATE 10

APPENDIX A

CHECK LIST - VISUAL INSPECTION AND FIELD SKETCH

Check List
Visual Inspection
Phase 1

Name of Dam Bradford City No. 5 Dam (Tuna Creek Dam) **County** McKean **State** PA **Coordinates** **Lat.** N 41° 53.8'

NDI # PA 00026
PennDER # 42-31

Long. W 78° 43.3'

Date of Inspection 8 Nov. 1978 **Weather** Partly cloudy **Temperature** 50°F.

Pool Elevation at Time of Inspection 1712.1 ft.* M.S.L. **Tailwater at Time of Inspection** 1653.0 ft.*M.S.L.

* All elevations are referenced to the crest of the principal spillway (El. 1712.0 ft.)

Inspection Personnel:

Michael Baker, Jr., Inc.:

Rodney E. Holderbaum
Thomas W. Smith
James G. Ulinski

Site Visit - 16 June 1979

James G. Ulinski

Owner's Representatives
(Bradford City Water Authority):

Dave Maben, Foreman (part-time)

James G. Ulinski **Recorder**

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE		
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS		
DRAINS		
WATER PASSAGES		
FOUNDATION		

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES		
STRUCTURAL CRACKING		
VERTICAL AND HORIZONTAL ALIGNMENT		
MONOLITH JOINTS		
CONSTRUCTION JOINTS		

EMBANKMENT

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Numerous holes below toe of dam. Most of the holes are approximately 2 ft. by 2 ft. in plan view and 18 in. deep; however, one hole was at least 6 ft. deep. Water was standing in a couple of the deeper holes approximately 1 to 2 ft. below the ground surface. See field sketch for approximate location.	The cause of these holes was not readily discernible. This area should be investigated in detail.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	The soil backfill in the observation deck at the right abutment of the spillway has eroded near the retaining walls.	This is a minor problem and can be handled by routine maintenance, i.e., bringing these areas up to grade and reseeding.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	No problems were observed.	
RIPRAP FAILURES	None	

EMBANKMENT

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RODENT HOLES	Rodent holes were observed at two locations: 1) 710 ft. left of the right abutment, 25 ft. below the crest and 2) 875 ft. left of the right abutment, 8 ft. below the crest.	These holes should be repaired.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	The joint filler between the observation deck retaining wall and the adjacent spillway training wall needs to be replaced.	
ANY NOTICEABLE SEEPAGE	1. Flow was exiting from behind the right wing wall of the outlet structure of the outlet conduit. This clear seepage was estimated to be flowing at a rate of 5 g.p.m.	1. This flow is not considered harmful at this time; however, repair of the catch basin outlet pipe and extending the concrete gutter (or a pipe) past the outlet head wall may solve this problem.
	2. Clear flow was exiting from the in situ knoll adjacent to the spillway chute. The rate of flow was estimated at 1 g.p.m.	2. This seepage should be periodically observed in the future.
	3. Clear flow was exiting to the ground surface and then flowing on the ground surface at a point 200 ft. downstream from the toe. This seepage was flowing at an estimated rate of 20 g.p.m. See the field sketch for the locations of the seepage areas.	3. Cause should be determined as a part of the detailed investigations of the holes in the downstream area.

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
STAFF GAGE AND RECORDER	None	
DRAINS	A basin for observing the flow in a 4 in. clay tile drain is located at the left toe of the embankment (see item 14, field sketch). This drain is not noted in the design plans or in the construction correspondence reviewed. The rock toe drain was observed to be overgrown with trees and brush near the center of the dam.	Flow in this drain should be periodically monitored. The trees and brush should be removed during routine maintenance.

OUTLET WORKS

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Spalling of the concrete in the outlet conduit was observed in several places, thereby exposing the reinforcing steel.	The spalled areas should be repaired with suitable material.
INTAKE STRUCTURE	No problems were observed.	
OUTLET STRUCTURE	The concrete outlet structure was in good condition at the time of the inspection.	
OUTLET CHANNEL	There is some debris located in the outlet channel. Otherwise, the channel is in relatively good condition.	Debris should be periodically removed from the outlet channel.
EMERGENCY GATE	An 8 ft. diameter gated outlet conduit can be used for emergency drawdown or to discharge excess flood waters. The gate controls are located in the intake tower.	The gates are operated annually to ensure proper operation.

UNGATED SPILLWAY

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Water was discharging over the weir at the time of the inspection, thereby making a detailed inspection difficult. It did not appear, however, that there were any serious deficiencies.	
SPILLWAY APPROACH	No problems were observed.	
DISCHARGE CHANNEL	Minor amounts of debris were located in the discharge channel. Some cracking and leaching of the concrete has occurred at several places. Joint filler is missing in some places. Note: On 16 June 1979 only a minor amount of debris was present, negating the need for removal of the debris.	The debris should be removed, and the cracks and joints should be sealed with a suitable material.
BRIDGE AND PIERS	Not Applicable	

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

GATED SPILLWAY - Not Applicable

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL		
APPROACH CHANNEL		
DISCHARGE CHANNEL		
BRIDGE AND PIERS		
GATES AND OPERATION EQUIPMENT		

INSTRUMENTATION

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None observed	
WEIRS	Small V-notch weirs are located at the toe of the right abutment and downstream from the outlet conduit.	Weir measurements are no longer taken at either of these weirs.
PIEZOMETERS	None observed	
OTHER	None	

RESERVOIR

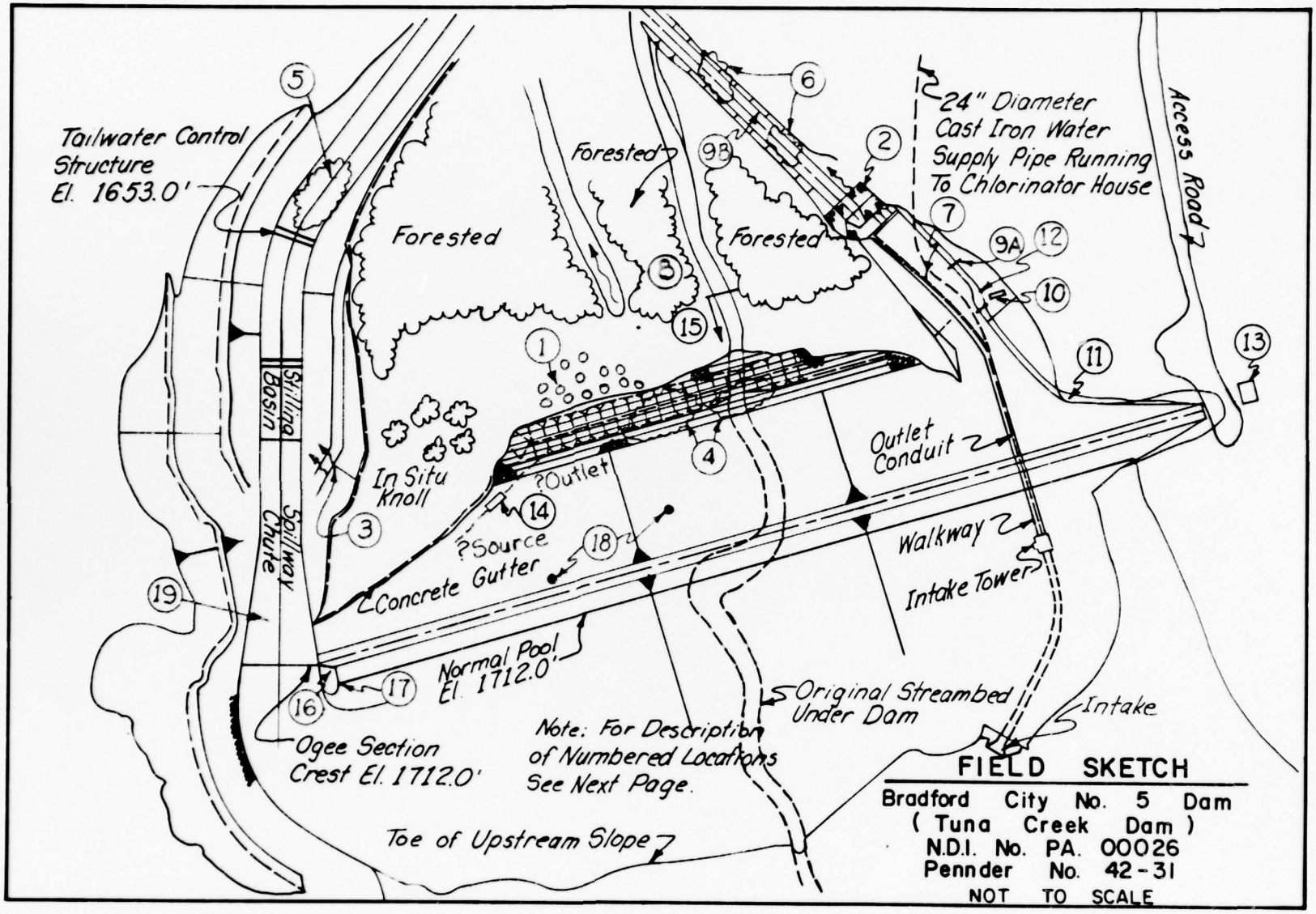
Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are relatively steep and primarily forested.	
SEDIMENTATION	An accurate estimate of the sedimentation is not available. Judging from the age of the structure and the watershed cover; however, the degree of sedimentation should not be excessive.	

DOWNSTREAM CHANNEL

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel follows its course through a relatively wide, forested valley. No unusual obstructions or debris were observed.	
SLOPES	The slope of the downstream channel is moderate, averaging less than 1% during its 5 mi. course to the city of Bradford.	
APPROXIMATE NO. OF HOMES AND POPULATION	Two homes are located in low-lying areas approximately 3000 ft. below the dam. Approximately 10 other homes are located in the floodplain along the 5 mi. reach between the dam and the city of Bradford.	


Tailwater Control Structure El. 1653.0'
Forested
Forested
Forested
24" Diameter Cast Iron Water Supply Pipe Running To Chlorinator House
Access Road
Stilling Basin
Spillway Chute
In Situ Knoll
?Outlet
?Source
Concrete Gutter
Outlet Conduit
Walkway
Intake Tower
Normal Pool El. 1712.0'
Original Streambed Under Dam
Intake
Ogee Section Crest El. 1712.0'
Note: For Description of Numbered Locations See Next Page.
Toe of Upstream Slope
FIELD SKETCH
Bradford City No. 5 Dam
(Tuna Creek Dam)
N.D.I. No. PA. 00026
Pennder No. 42-31
NOT TO SCALE

BRADFORD CITY No. 5 DAM (TUNA CREEK DAM)
NDI No. PA 00026, PennDER No. 42-31

FIELD SKETCH DESCRIPTIONS

1. Numerous holes below toe of dam. Most of the holes are approximately 2 feet by 2 feet in plan view and 18 inches deep. However, one hole was at least 6 feet deep. Water was standing in a few of the deeper holes approximately 1 to 2 feet below the ground surface.

2. Flow was exiting from behind the right wing wall of the outlet structure of the outlet conduit. This flow as clear and was flowing at an estimated rate of 5 g.p.m.

3. Flow was exiting from the in situ knoll adjacent to the spillway chute channel at an estimated rate of 1 g.p.m. The flow was clear.

4. Trees and shrubs are growing out from the rock toe drain near the center of the dam and to a limited extent immediately below the toe of the dam.

5. Trees and vegetation are present in the spillway outlet channel below the tailwater control structure.

6. Some debris is in the outlet channel.

7. The soffit of the outlet conduit is spalled in several locations.

8. Flow at an estimated rate of 20 g.p.m. is exiting to the ground surface approximately 200 feet downstream from the dam. From there it flows as a surface stream to the outlet channel.

9A. Abandoned seepage weir along right hillside in earth ditch.

9B. Abandoned weir in the outlet conduit discharge channel.

10. Disjointed clay pipe on right hillside approximately 150 feet below the dam. This pipe originally served as the outlet for the catch basin to the right of the access road at the crest of the dam (see item 13).

11. Concrete gutter along the downstream junction of dam and the right abutment hillside. The paved section ends approximately 25 feet below the toe of the dam.

12. The ditch below the concrete gutter was wet. The location of the drain outlet noted in the correspondence could not be found.

13. Catch basin for surface runoff above the right abutment of the dam.

14. Small basin for drain outlet. A 4-inch clay pipe was flowing 3 inches deep on 16 June 1979.

15. The noted location of the original stream channel below the toe was filled during construction. However, the remainder of the channel was observable and was only slightly wet at the edge of the forested areas noted.

16. The observation deck backfill has settled adjacent to the walls.

17. A hole has been chipped through the concrete retaining wall of the observation deck.

18. The approximate location of rodent holes in the embankment are noted on the field sketch.

19. Some cracking and leaching of the concrete has occurred at several places in the discharge channel. Also, the joint filler is missing in some places. Some debris in the spillway was noted during the original inspection; however, during the site visit, only a minor amount of debris was present.

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

ITEM	REMARKS

PLAN OF DAM See Plate 3 of this report.

REGIONAL VICINITY MAP A portion of a USGS 7.5 minute topographic quadrangle Bradford, Pennsylvania, was used to prepare the vicinity map which is attached in this report as the Location Plan, Plate 1.

CONSTRUCTION HISTORY Bradford City No. 5 Dam was designed by Gannett Fleming Corddry and Carpenter, Inc., Harrisburg, Pennsylvania. The contractor was Buck and Donohue, Inc., 790 Broad Street, Newark, New Jersey. Construction of the dam commenced on 20 June 1955 and the final inspection of the construction was performed on 11 July 1957. Information contained in the semi-monthly construction progress reports indicates that the contractor did not place any compacted fill or other weather sensitive material during the winter months and wet periods. The pre-final inspection report dated 21 June 1957 states that the dam was constructed according to the original design drawings except for two minor changes:

1) Concrete was used for gutters instead of rock.
2) Additional concrete was used in footers at the entrance of the spillway.

Also, the progress reports noted changes in the bottom elevation of the ogee spillway and the addition of a tile drain at the east (right) abutment. The contractor reported placing 1250 c.y. of Class B concrete under the ogee weir to replace the over excavation necessary to reach sound rock. The extra tile drain was necessary to relieve seepage from a ground-water spring. The tile drain was installed from the spring location near the grout cap in the east abutment to the exit at the toe of the embankment.

TYPICAL SECTIONS OF DAM See Plates 4, 5, 6, 7 and 8 of this report. Additionally, the complete set of design drawings is readily available in PennDER's file for this dam.

HYDROLOGIC/HYDRAULIC DATA Storage and discharge capacity curves are available as part of the design plans. No hydrologic data were available.

Name of Dam: Bradford City No. 5 Dam
NDI # PA 00026

ITEM	REMARKS
DESIGN REPORTS	No design reports were available. Information reviewed included the original design drawings, contract documents (specifications), and Permit Application Report by the Water and Power Resources of the Department of Forests and Waters. All additional information contained in the files of Gannett Fleming Corddry and Carpenter, Inc., of Harrisburg, Pennsylvania was destroyed in a flood in 1972.
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Sheet 3, Foundation Exploration Plan, of the original design drawing is included in this report as Plate 9. Sheets 4 and 5, Foundation Exploration Logs I and II, respectively, are available in PennDER's file for this dam. A report entitled "Foundation Investigation and Soil Exploration" is available in PennDER's file for this dam. This report, dated July 1954, was prepared by Dr. Louis Berger, Consulting Engineer. Information contained in the report includes the results of the exploration and laboratory soil testing programs.
POST-CONSTRUCTION SURVEYS OF DAM	No information available
BORROW SOURCES	Borrow material for the dam was obtained from excavation at the dam site and from two borrow pits located a minimum of 1200 ft. upstream from the axis of the dam in the reservoir area. The location of these borrow pits are shown on Sheet 1 of the design drawings.
OUTLETS - PLAN AND DETAILS	See plates 6 and 7 of this report. Also, sheets 10, 11, 12, 13, 14, 15, 15a, 15b, 15c, 16, 17, 18 and 19 of the design drawings (available in PennDER's file).
- CONSTRAINTS	A 4 ft. sluice gate is located on the 8 ft. blow-off pipe at the gate house.
- DISCHARGE RATINGS	A discharge rating cure for the blow-off pipe is available in the design plans.
RAINFALL/RESERVOIR RECORDS	No detailed reservoir/rainfall records are available.

ITEM	REMARKS
MONITORING SYSTEMS	None installed
MODIFICATIONS	No modifications noted except for the changes from the design plans as indicated under "CONSTRUCTION HISTORY" on page B-1.
HIGH POOL RECORDS	Available from the Bradford City Water Authority
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	The dam has been inspected three times by representatives of PennDER including the most recent inspection on 20 September 1977. The inspection reports are available in the PennDER file for this dam.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	No maintenance or operation records are available.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Plate 8 of this report shows the plan and section of the spillway. Additional details are shown on Sheets 21-28 of the original design drawings (available in PennDER's files).
OPERATING EQUIPMENT PLANS & DETAILS	Plates 6 and 7 of this report show plan and sections of the intake structure and outlet conduit. Additional information is shown on Sheets 10-19 of the original design drawings (available in PennDER's files).

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 6.60 sq. mi. (primarily forested)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1712.0 ft. (2090 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1723.0 ft. (3390 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1723.0 ft.

PRINCIPAL SPILLWAY:

a. **Elevation** 1712.0 ft.
b. **Type** Concrete ogee and chute channel
c. **Width** 93 ft. at crest
d. **Length** 360 ft. (including stilling basin)
e. **Location Spillover** Left abutment of dam
f. **Number and Type of Gates** Not Applicable

OUTLET WORKS:

a. **Type** Reinforced concrete riser and 8 ft. diameter concrete outlet pipe
b. **Location** Approximately 325 ft. from right abutment
c. **Entrance inverts** El. 1663.0 ft.
d. **Exit inverts** El. 1649.4 ft.
e. **Emergency draindown facilities** 4 ft. diameter manually operated sluice gate

a. Type 24-in. diameter water supply pipe
b. Location Originates at concrete riser
c. Entrance inverts El. 1666.0 ft.
d. Exit inverts Not Applicable
e. Emergency draindown facilities Not Applicable

HYDROMETEOROLOGICAL GAGES: Not Applicable

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown

APPENDIX C

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall Views of Dam

Upper Photo - Overall View of Dam from Right Abutment (Intake Tower and Walkway in Left of Photo)

Lower Photo - Overall View of Dam from Left Abutment (Entrance to Ogee Spillway at Right-Bottom of Photo)

Photo 1 - View Looking Upstream at Ogee Spillway and Stilling Basin

Photo 2 - Detail View of Ogee Section at Spillway and Right Spillway Training Wall

Photo 3 - View Looking Downstream at Stilling Basin and Discharge Channel

Photo 4 - View of Upstream Slope and Riprap Protection

Photo 5 - View of Intake Tower and Walkway

Photo 6 - View of Outlet Conduit Head Wall and Discharge Channel (Note: The Conduit is 8 Feet in Diameter at the Outlet Head Wall.)

Photo 7 - View of the Downstream Slope

Photo 8 - View of the Rock Drain at Toe of Downstream Slope

Photo 9 - Close-up View of One of Vertical Holes Downstream of Rock Drain

Photo 10 - Location View of Photo 9 (Note Toe Drain, Crest of Dam and Trees Growing in Toe Drain)

Photo 11 - Close-up View of Seepage Exiting Near Outlet Conduit Head Wall

Photo 12 - Close-up View of Seepage Exiting 200 Feet Downstream of Toe Drain

Photo 13 - Location View of Photo 12 in Relation to Toe Drain and Dam Crest

Note: Overall Views and Photos 1-8 were taken on 8 November 1978. Photos 9-13 were taken on 16 June 1979.

BRADFORD CITY No. 5 DAM

PHOTO 1. View Looking Upstream at Ogee Spillway and Stilling Basin

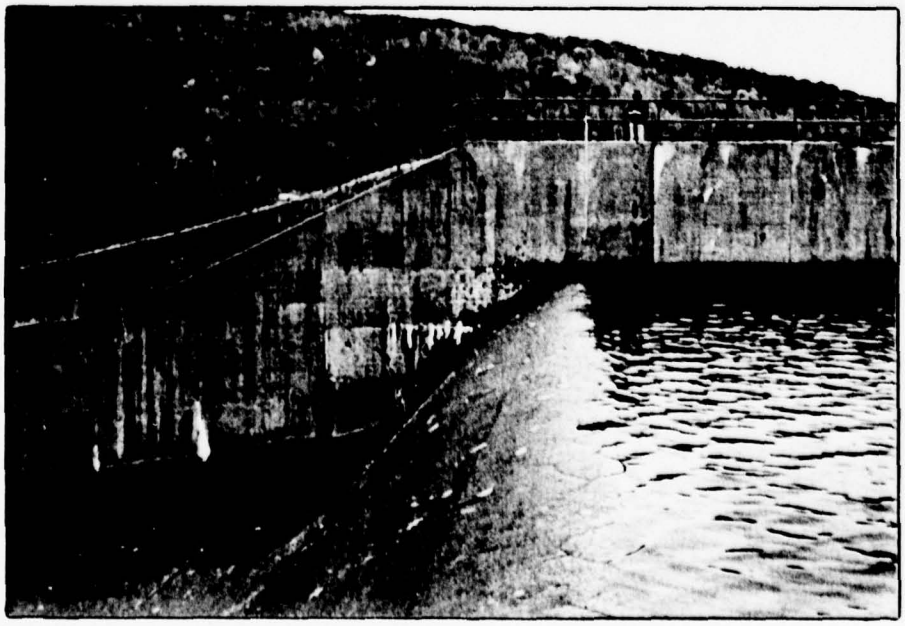


PHOTO 2. Detail View of Ogee Section at Spillway and Right Spillway Training Wall

BRADFORD CITY No. 5 DAM

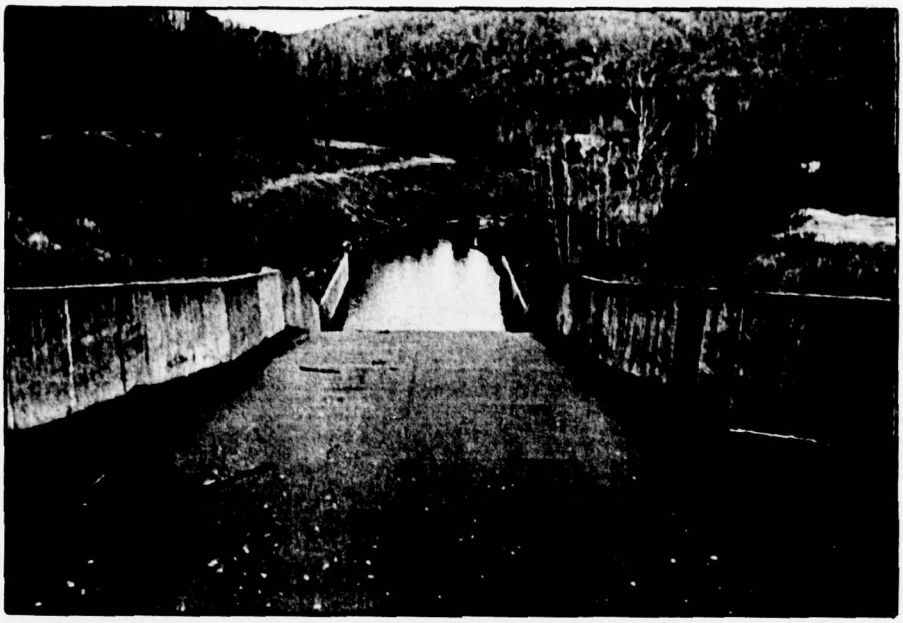


PHOTO 3. View Looking Downstream at Stilling Basin and Discharge Channel

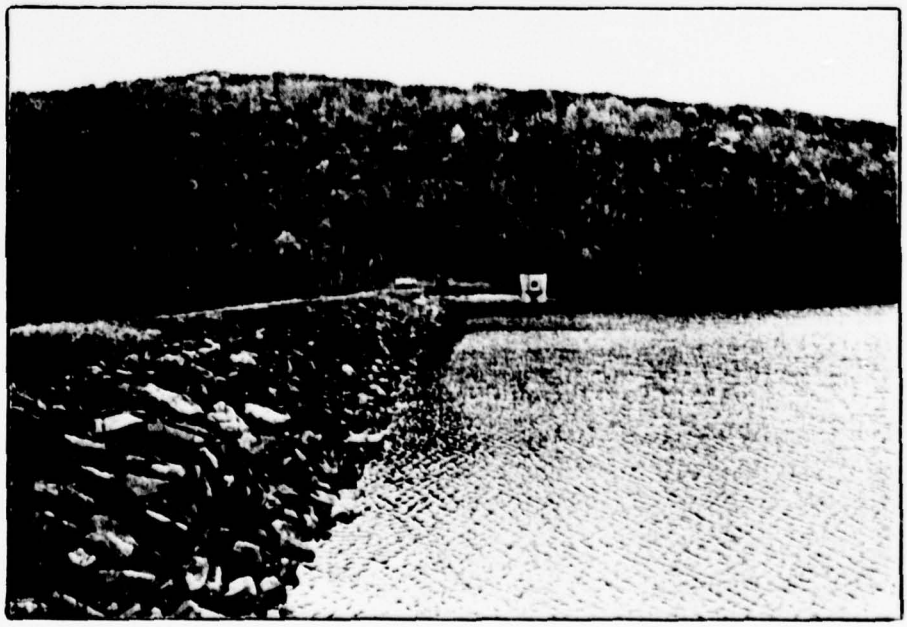


PHOTO 4. View of Upstream Slope and Riprap Protection

BRADFORD CITY No. 5 DAM

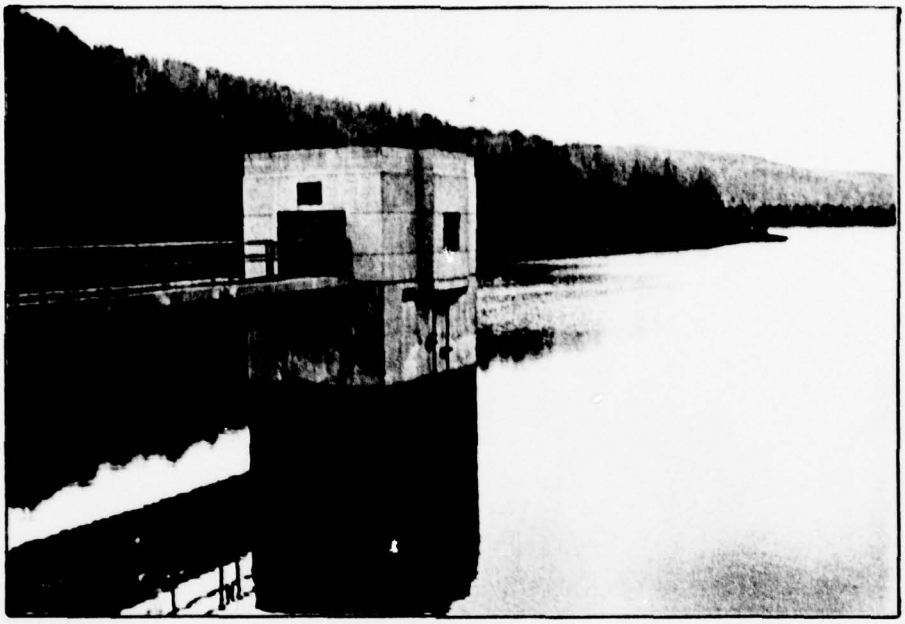


PHOTO 5. View of Intake Tower and Walkway

PHOTO 6. View of Outlet Conduit Head Wall and Discharge Channel
(Note: The Conduit is 8 Feet in Diameter at the Outlet Head Wall.)

BRADFORD CITY No. 5 DAM

PHOTO 7. View of the Downstream Slope

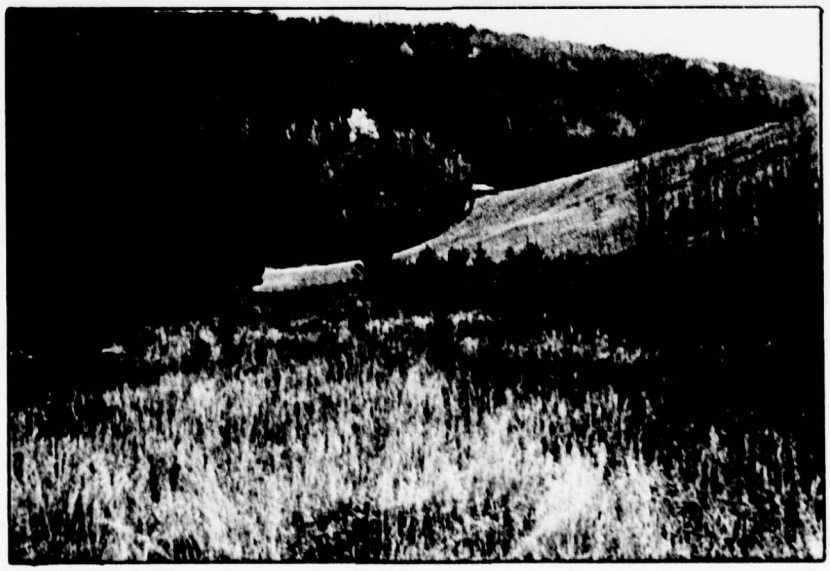


PHOTO 8. View of Rock Drain at Toe of Downstream Slope

location of the drain outlet noted in the correspondence could not be found.

BRADFORD CITY No. 5 DAM

PHOTO 9. Close-up View of One of Vertical Holes Downstream of Rock Drain

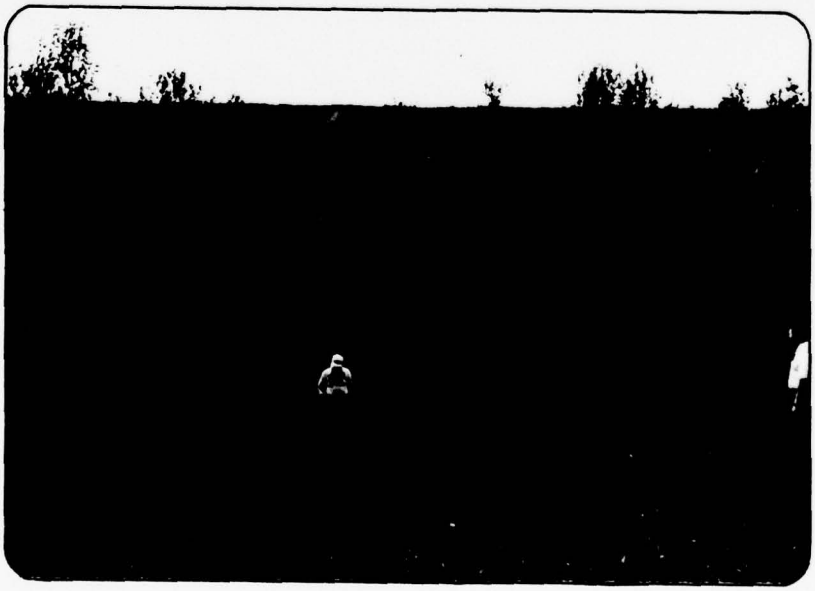


PHOTO 10. Location View of Photo 9
(Note Toe Drain, Crest of Dam and Trees Growing in Toe Drain.)

PHOTO 11. Close-up View of Seepage Exiting Near Outlet Conduit Head Wall

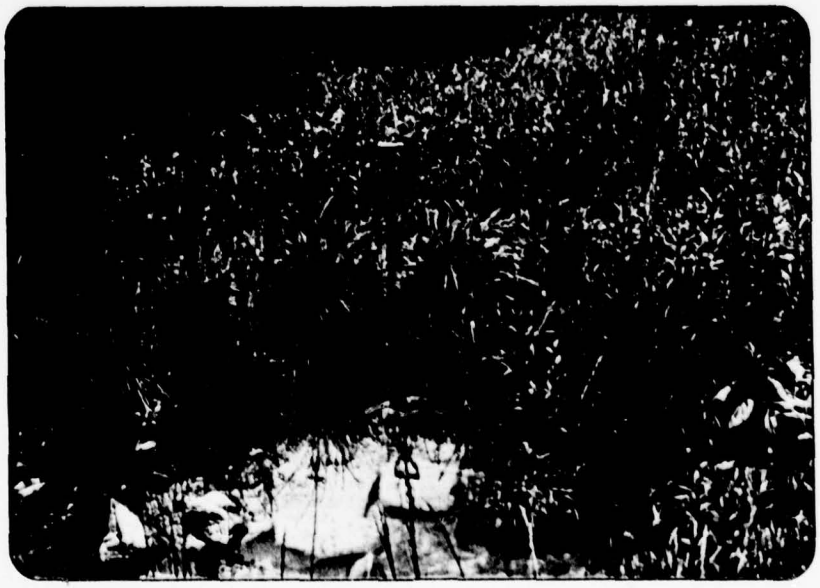


PHOTO 12. Close-up View of Seepage Exiting 200 Feet Downstream of Toe Drain

BRADFORD CITY No. 5 DAM

PHOTO 13. Location View of Photo 12 in Relation to Toe Drain and Dam Crest

Name of
NDI # PA

ITEM

PLAN OF

REGIONAL

CONSTRUCT

TYPICAL SE

HYDROLOGIC/

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford City No. 5 Dam (Tuna Creek Dam) S.O. No. _____ Sheet No. _____ of _____ Drawing No. _____

Computed by _____ Checked by _____ Date _____

Table of Contents

Name of Da
NDI # PA 00

ITEM

MONITORING

MODIFICATIO

HIGH POOL

POST-CONSTR
STUDIES AND

PRIOR ACCID
DESCRIPTION
REPORTS

MAINTENANCE
OPERATION
RECORDS

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford City No. 5 Dam (Tuna Creek Dam) S.O. No. _____
Rainfall and Hydrograph Data Sheet No. 1 of 11
Drawing No. _____
Computed by G.A.S. Checked by REH Date 2-22-79

Rainfall Data: (From HMR-33)

PMP (24 hr - 200 sq. mi.) = 22.8 in. (zone 2)

P(6 hr.) = 117% PMP
P(12 hr.) = 127% PMP
P(24 hr.) = 141% PMP
P(48 hr.) = 151% PMP

Hydrograph Data:

Two major tributaries drain into the reservoir: (Both in zone 23)

Sub-basin A: (D.A. = 2.48 mi.²)

$L = 3.20$ mi. $L_{ca} = 1.63$ mi.

$t_p = 3.3 (L L_{ca})^{0.3} = 3.3 (3.20 \cdot 1.63)^{0.3}$

$t_p = 5.42$ hours

$t_{pR} = t_p + 0.25 (t_R - t_r)$

$t_{pR} = 5.42 + 0.25 (0.25 - 5.42/5.5) = 5.24$ hrs.

Sub-basin B: (D.A. = 4.12 mi.²)

$L = 3.33$ mi. $L_{ca} = 1.39$ mi.

$t_p = 3.3 (L L_{ca})^{0.3} = 3.3 (3.33 \cdot 1.39)^{0.3}$

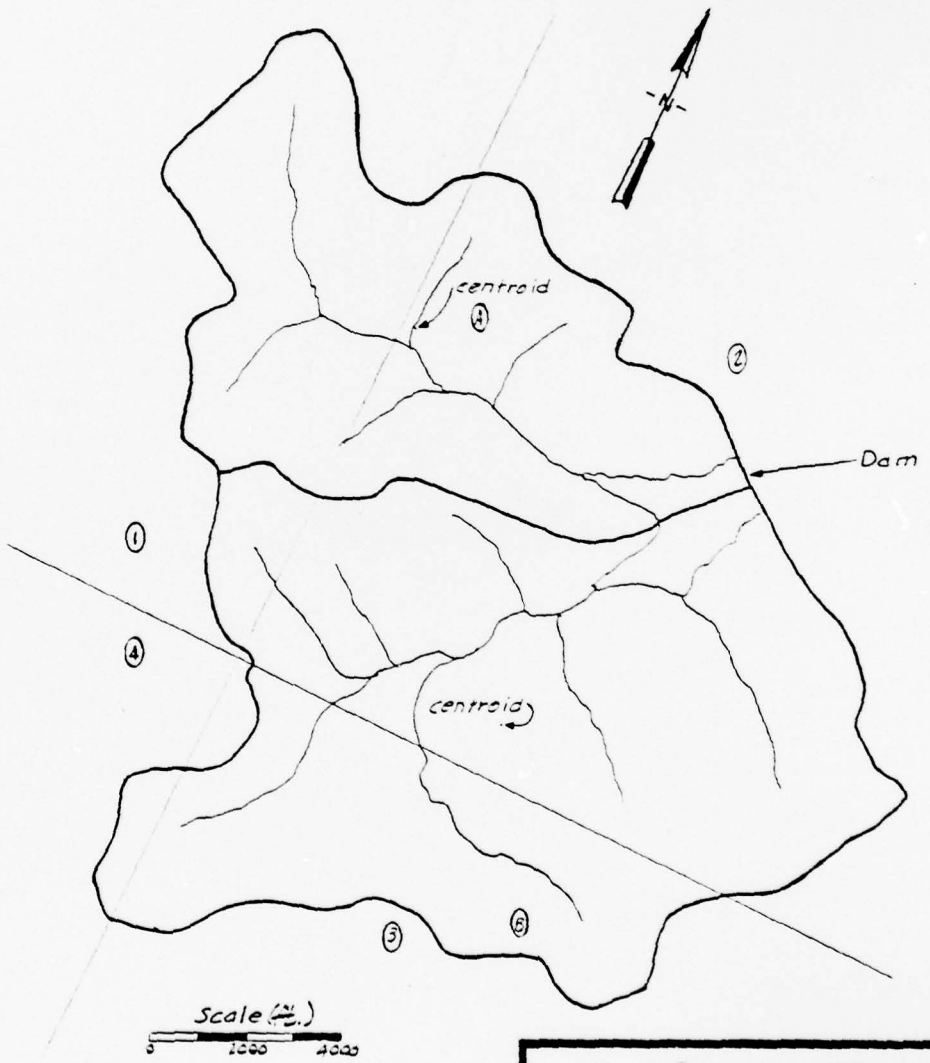
$t_p = 5.23$ hours

$t_{pR} = t_p + 0.25 (t_R - t_r)$

$t_{pR} = 5.23 + 0.25 (0.25 - 5.23/5.5) = 5.05$ hrs.

C_p (both basins) = 0.55

$t_p = 3.3 (L L_{ca})^{0.3} \Rightarrow$ from plate L (since both sub-basins are in zone 23)



Quads: 1. Sticknev
2. Bradford
3. Lewis Run
4. Westline

A. Drainage Area = 2.48 mi.²
L = 3.2 mi. Lca = 1.63 mi.

B. Drainage Area = 4.12 mi.²
L = 3.33 mi. Lca = 1.39 mi

DATE: 3-29-79 gas

West Branch of Tuna Creek Watershed at Bradford No. 5 Reservoir

MICHAEL BAKER JR. INC.
Consulting Engineers & Surveyors

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford City No. 5 S.O. No.
Stage - Storage - Discharge Sheet No. 3 of 11
Drawing No.
Computed by REH Checked by [illegible] Date 1-30-79

Elev. (ft.)	Storage (A.F.)	Discharge (cfs.)
1712	2090	0
1713	2185	520
1714	2295	1160
1715	2410	1900
1716	2510	2700
1717	2630	3760
1718	2750	5100
1719	2875	6600
1720	3010	8350
1721	3125	10,100
1722	3250	11,950
1723	3390	13,300

Note: The above information was taken from design plans. The discharge does not include flow from the 8 foot blow-off pipe.

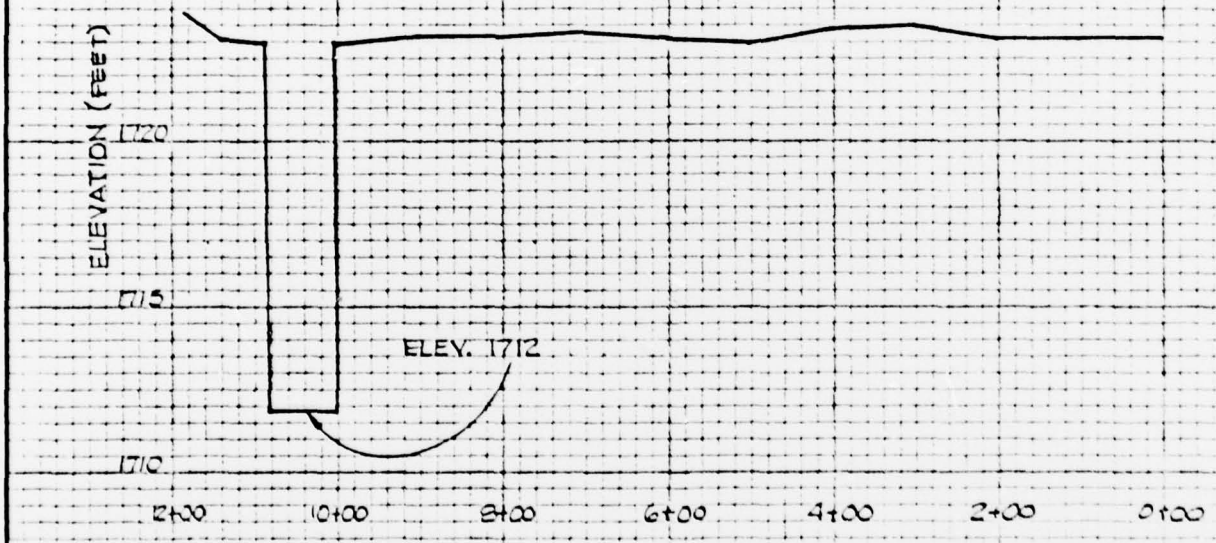
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject BRADFORD CITY NO. 5 DAM S.O. No.
TOP OF DAM PROFILE AND Sheet No. 4 of 11
OVERTOPPING DATA Drawing No.
Computed by GAS Checked by REH Date 2-23-79

DESIGN TOP OF DAM 1723 FT. M.S.L.
LENGTH = 1000 FEET

C (WEIR COEFFICIENT) = 2.65
2 (EXPONENT) = 1.5



NOTE: THE ABOVE DATA WAS DETERMINED DURING FIELD SURVEYS PERFORMED AT THE TIME OF THE INSPECTION.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject Bradford City No. 5
Map of Downstream Area

S.O. No.

Sheet No. 5 of 11

Drawing No.

Computed by Checked by Date 6/1/77

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  25 SEP 78
**********
     1                 AI       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
     2                 A2       HYDROLOGIC AND HYDRAULIC ANALYSIS OF TUNA CREEK DAM MBJ 18
     3                 A3       PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD
     4                 R    200       0      15       0       0       0       0       0      -1       0
     5                 R1     5
     6                 J      1       1       1
     7                 J1   1.0
     8                 *            TRIB-A
     9                 K1       INFLOW HYDROGRAPH FROM TRIBUTARY A
    10                 M      1       1    2.48                    6.00
    11                 P              22.8     117     127     141     151
    12                 T                                                      1.0     .05
    13                 W   5.24     .55
    14                 X   -1.5   -0.05     2.0
    15                 *            TRIB-B
    16                 K1       INFLOW HYDROGRAPH FROM TRIBUTARY B
    17                 M      1       1    4.12                    6.60
    18                 P              22.8     117     127     141     151
    19                 T                                                      1.0     .05
    20                 W   5.05     .55
    21                 X   -1.5   -0.05     2.0
    22                 K      2    LAKE                                          1
    23                 K1       COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM
    24                 K      1    SPWY                                          1
    25                 K1       ROUTING OF THE COMBINED FLOWS
    26                 *                                      1       1
    27                 Y1     1                                                -1712      -1
    28                 Y4  1712    1713    1714    1715    1716    1717    1718    1719    1720    1721
    29                 Y4  1722    1723
    30                 Y5     0     520    1160    1900    2700    3760    5100    6600    8350   10100
    31                 Y5 11950   13800
    32                 $F  2040    2165    2293    2410    2510    2630    2750    2875    3013    3125
    33                 $F  3250    3390
    34                 $F  1712    1713    1714    1715    1716    1717    1718    1719    1720    1721
    35                 $F  1722    1723
    36                 $$  1712
    37                 $D  1723    2.65     1.5    1000
    38                 K     99
```

11 pages

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*********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION        JULY 1978
  LAST MODIFICATION  25 SEP 78
*********************************

RUN  DATE 03/15/79
      TIME    20.18

                    NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
                    HYDROLOGIC AND HYDRAULIC ANALYSIS OF TUNA CREEK DAM MHJ  13
                    PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDERS METHOD

                                   JOB SPECIFICATION
       NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
      250       0      15       0       0       0       0       0      -4       0
                               JOPER     NWT   LROPT   TRACE
                                   5       0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                             NPLAN= 1 NRTIO= 1 LRTIO= 1
        RTIOS=    1.00

 **********      **********      **********      **********      **********

                              SUB-AREA RUNOFF COMPUTATION

        INFLOW HYDROGRAPH FROM TRIBUTARY A

                 ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                TRIB-A       0       0       0       0       0       0       0       0

                                    HYDROGRAPH DATA
       IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
           1      1    2.46     0.0    6.60     0.0     0.0       0       0       0

                                     PRECIP DATA
                 SPFE     PMS      R6     R12     R24     R48     R72     R96
                  0.0   22.80  117.00  127.00  141.00  151.00     0.0     0.0
TRSPC COMPUTED BY THE PROGRAM IS 0.800

                                      LOSS DATA
      LROPT  STRKR  DLTKR  RTIOL  ERAIN  STRKS  RTIOK  STRTL  CNSTL  ALSMX  RTIMP
          0    0.0    0.0   1.00    0.0    0.0   1.00   1.00   0.05    0.0    0.0

                                 UNIT HYDROGRAPH DATA
                           TP=  5.24    CP=0.55    NTA=  0

                                   RECESSION DATA
                     STRTQ=   -1.50    QRCSN=   -0.05    RTIOR= 2.00

        UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG=   5.28 HOURS, CP= 0.55  VOL= 0.97
          2.        7.       13.       22.       31.       41.       52.       64.       76.       88.
        101.      114.      126.      136.      146.      154.      161.      166.      170.      173.
        174.      173.      168.      162.      156.      149.      143.      138.      132.      127.
        122.      117.      112.      108.      103.       99.       95.       91.       88.       84.
         81.       78.       74.       71.       69.       66.       63.       61.       58.       56.
```

54.	52.	47.	47.	46.	44.	42.	40.	39.	37.
36.	34.	33.	32.	30.	29.	28.	27.	26.	25.
24.	23.	22.	21.	20.	19.	19.	18.	17.	16.
16.	15.	14.	14.	13.	13.	12.	12.	11.	11.
10.	10.	10.	9.	9.	9.	8.	8.	8.	7.

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	27.54	25.11	2.43	154574.
										(700.1(	638.1(	62.1(	4377.05)

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH FROM TRIBUTARY 8

	ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
TRIB-8		0	0	0	0	0	0	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	4.12	0.0	6.60	0.0	0.0	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	22.80	117.00	127.00	141.00	151.00	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	1.00	0.05	0.0	0.0

UNIT HYDROGRAPH DATA

TP= 5.05 CP=0.55 NTA= 0

RECESSION DATA

STRTQ= -1.50 QRCSN= -0.05 RTIOR= 2.00

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 5.06 HOURS, CP= 0.55 VOL= 0.98

3.	12.	25.	40.	57.	76.	96.	117.	139.	162.
185.	208.	229.	246.	262.	275.	285.	293.	298.	300.
298.	291.	279.	268.	257.	246.	236.	226.	217.	208.
199.	191.	183.	175.	168.	161.	154.	148.	142.	136.
130.	125.	120.	115.	110.	105.	101.	97.	93.	89.
85.	82.	78.	75.	72.	69.	66.	63.	61.	58.
56.	53.	51.	49.	47.	45.	43.	41.	40.	38.
37.	35.	34.	32.	31.	30.	28.	27.	26.	25.
24.	23.	22.	21.	20.	19.	19.	18.	17.	16.
16.	15.	14.	14.	13.	13.	12.	12.	11.	11.

Sheet 8 of 11

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	27.54	25.11	2.43	298117.
										(700.1(	638.1(	62.1(	7309.13)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE THE TWO TRIBUTARIES FOR ROUTING THROUGH THE DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	2	0	0	0	0	1	0	0

HYDROGRAPH ROUTING

ROUTING OF THE COMBINED FLOWS

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
SPWY	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP		LSTR
0.0	0.0	0.0	1	1	0	0		0

NSTPS	NSTOL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.0	0.0	0.0	-1712.	-1

STAGE	1712.00	1713.00	1714.00	1715.00	1716.00	1717.00	1718.00	1719.00	1720.00	1721.00
	1722.00	1723.00								
FLOW	0.0	520.00	1160.00	1900.00	2700.00	3760.00	5100.00	6650.00	8350.00	10150.00
	11950.00	13800.00								
CAPACITY=	2090.	2185.	2295.	2410.	2510.	2630.	2750.	2875.	3010.	3125.
	3250.	3390.								
ELEVATION=	1712.	1713.	1714.	1715.	1716.	1717.	1718.	1719.	1720.	1721.
	1722.	1723.								

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1712.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1723.0	2.6	1.5	1000.

PEAK OUTFLOW IS 8697. AT TIME 45.50 HOURS

11 of 6 sheets

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	TRIB-A	2.48	1	3347.
		(6.42)		(94.78)
HYDROGRAPH AT	TRIB-B	4.12	1	5726.
		(10.67)		(162.14)
2 COMBINED	LAKE	6.60	1	9073.
		(17.09)		(256.84)
ROUTED TO	SPWY	6.60	1	8697.
		(17.09)		(246.27)

Sheet 10 of 11

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1712.00	1712.00	1723.00
STORAGE	2090.	2090.	3370.
OUTFLOW	0.	0.	13800.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1720.20	0.0	3033.	8697.	0.0	45.50	0.0

Sheet 11 of 11

APPENDIX E

REGIONAL GEOLOGY

BRADFORD CITY No. 5 DAM
(TUNA CREEK DAM)
NDI No. PA 00026, PennDER No. 42-31

REGIONAL GEOLOGY

Bradford City No. 5 Dam is located near the head of the valley of the West Branch of Tunungwant (Tuna) Creek in the Appalachian Plateaus physiographic province. Although this section has not been glaciated, the dam area has been affected by glacial outwash.

Bedrock units beneath the dam are members of the Cattaraugus formation of the Upper Devonian system. The strata have nearly horizontal bedding but are gently folded regionally. Specifically, as described on boring logs made for design of the dam, bedrock consists of a sequence of soft and medium hard red and gray shales with some interbedded sandstone.

The test borings also penetrated soils up to 59 feet thick on the floodplain and about 25 feet thick on the sides of the valley. Typically, these deposits were described as sandy or silty clays containing, in places, sandstone boulders and shale or quartzite pebbles. Many of the auger borings met refusal on boulders. Geologic references indicate these soils to be glacial lake and stream deposits.

No specific groundwater information was given on the boring and test pit logs except for one boring in the spillway area which indicated water at a depth of 13 feet.

The geologic map and legend on the following pages show the relationship of the dam site to regional geology.

GEOLOGIC MAP
Bradford City No. 5 Dam
NDI No. PA 00026 McKean County

Reproduced from Map of the Glacial Deposits of Northwestern Pennsylvania, Bulletin G-32 Pennsylvania Geological Survey, 4th Series

Scale One Inch Equals Approximately Two Miles

See Legend, Next Page

LEGEND

PERMIAN

Greene Formation

Cyclic sequences of sandstone, shale, red beds, limestone and coal; base at the top of the Upper Washington Limestone.

PERMIAN AND PENNSYLVANIAN

Pwg

Washington Formation

Cyclic sequences of sandstone, shale, limestone and coal; some red shale, some mineable coal; base at the top of the Waynesburg Coal.

PENNSYLVANIAN

APPALACHIAN PLATEAU

Pm

Monongahela Formation

Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern outcrop areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.

Pc

Conemaugh Formation

Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.

Pa

Allegheny Group

Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section; includes Freeport, Kittanning, and Clarion Formations.

Pp

Pottsville Group

Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION

Ppp

Post-Pottsville Formations

Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.

Pp

Pottsville Group

Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.

MISSISSIPPIAN

Mmc

Mauch Chunk Formation

Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Loyalhanna Limestone at the base in southwestern Pennsylvania.

Mp

Pocono Group

Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau, Burgoon, Shenango, Cuyahoga, Corry, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

DEVONIAN

UPPER

WESTERN PENNSYLVANIA

Doe Dr

Oswayo Formation

Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward; considered equivalent to type Oswayo. Riceville Formation, Dr, in Erie and Crawford Counties; probably not distinguishable north of Corry.

Dcr

Cattaraugus Formation

Red, gray and brown shale and sandstone with the proportion of red decreasing westward; includes Venango sands of drillers and Salamanca sandstone and conglomerate, some limestone in Crawford and Erie counties.

Dct

Conneaut Group

Alternating gray, brown, greenish and purplish shales and siltstones; includes "pink rock" of drillers and "Chemung" and "Girard" Formations of northwestern Pennsylvania.

Dcn

Canadaway Formation

Alternating brown shales and sandstones; includes "Portage" Formation of northwestern Pennsylvania.

APPENDIX F

STRUCTURAL STABILITY

AD-A078 866 BAKER (MICHAEL) JR INC BEAVER PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. BRADFORD CITY NUMBER 5 DAM (TU--ETC(U)
AUG 79 C Y CHEN DACW31-79-C-0011
UNCLASSIFIED NL

2 OF 2
AD A078866

END
DATE FILMED
1-80
DDC

Bradford City No. 5 Dam
NDI # PA 00026

GRAVITY DAM DESIGN

STABILITY ANALYSIS

ANALYSIS DONE ON X FULL SECTION ___ PARTIAL SECTION
LOCATION OF SECTION Concrete ogee spillway - left abutment of dam
ANALYSIS PREPARED BY Jim Ulinski, Michael Baker, Jr., Inc.

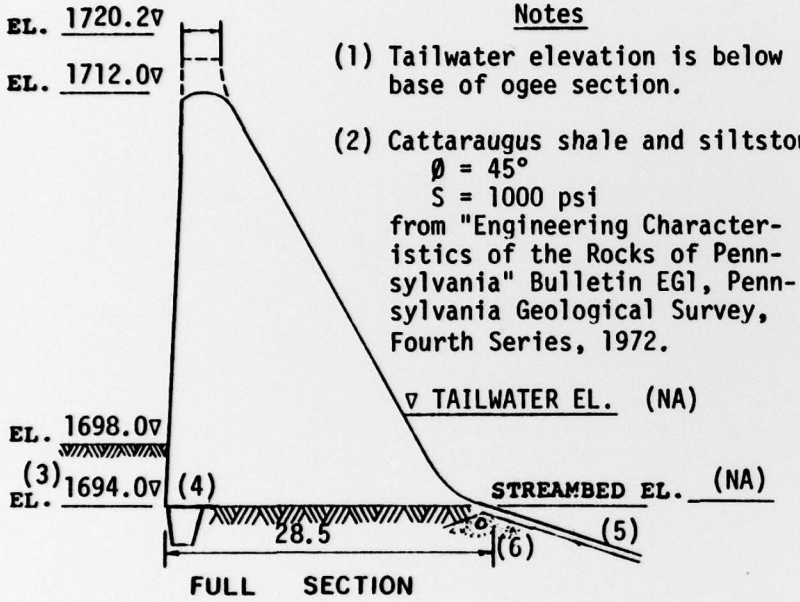
Bradford City No. 5 Dam
NDI # PA 00026

GRAVITY DAM DESIGN

STABILITY ANALYSIS

ANALYSIS DONE ON X FULL SECTION __ PARTIAL SECTION
LOCATION OF SECTION Concrete ogee spillway - left abutment of dam
ANALYSIS PREPARED BY Jim Ulinski, Michael Baker, Jr., Inc.

LOADING CASE	ELEV. HEAD WATER	ELEV. TAIL(1) WATER	ΣV	ΣH	$\frac{\Sigma H}{\Sigma V}$	LOCATION RESULTANT FROM TOE	% BASE IN COMPRESS.	FACTOR SAFETY SLIDING	FOUNDATION PRESS.	
									TOE	HEEL
Case I P.M.F.	1720.2	1664.6	19,369#	19,225#	0.99	11.5'	100	222(2)	1073 psf	286 psf
Case II Normal Pool Ice Load	1712.0	1653.0	26,494#	20,225#	0.76	10.1'	100	211(2)	1830 psf	29 psf

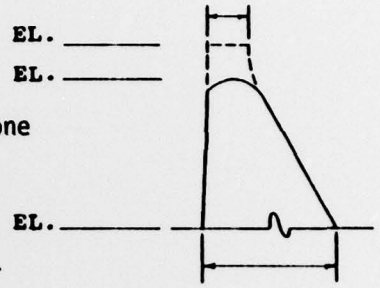


FULL SECTION

Notes

(1) Tailwater elevation is below base of ogee section.

(2) Cattaraugus shale and siltstone
$\phi = 45°$
S = 1000 psi
from "Engineering Characteristics of the Rocks of Pennsylvania" Bulletin EG1, Pennsylvania Geological Survey, Fourth Series, 1972.



PARTIAL SECTION (NA)

Notes (cont.)

(3) Design base El. 1694.0 used in stability computations.

(4) Failure plane assumed to shear through concrete key.

(5) The spillway chute carries discharges away from toe of the ogee section.

(6) Drainage gallery provided beneath chute slab and at toe of ogee section.